

**FINAL  
PHASE II (a) FIELD SAMPLING PLAN FOR  
GUN AND MORTAR POSITIONS**

**OF THE  
CAMP EDWARDS IMPACT AREA  
GROUNDWATER QUALITY STUDY**

**MASSACHUSETTS MILITARY RESERVATION  
CAPE COD, MASSACHUSETTS**

**Prepared for**

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# Final Phase II (a) Gun/Mortar FSP



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# Final Phase II (a) Gun/Mortar FSP



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## 1.0 Introduction

The following text was extracted from the Phase II(a) Workplan (Ogden, 1998a) and Change 1 to the Phase II(a) Workplan (Ogden, 1999a).

Phase I of the IAGS included investigation of representative gun and mortar positions in accordance with the final Action Plan (ETA, 1997) and the Final FSP for Gun and Mortar Positions (Ogden, 1998c). The locations investigated were selected, based on records of the quantities of rounds fired, to be representative of positions in either low, medium, or high use. The Phase I results indicate that there is no evidence of munitions-related contaminants at mortar positions (Ogden, 1998b). At gun positions, the results indicate the presence of propellants in shallow soil, at frequencies proportional to the amount of gun position use. ...

EPA has requested additional sampling in light of the limited number of positions sampled in Phase I. The following text from the Phase II(a) Workplan describes the investigation approach (Ogden, 1999a).

To evaluate the previous soil composite sampling scheme, the previously sampled high use gun position (Area 16 or GP-16) will be resampled. The nine-point grid with the highest PEP concentrations from Phase I will be overlaid with two five-point grids, each measuring 22.3x22.3 feet. The two five-point grids will have all five subsamples separately homogenized and split into two subsamples, one used for the composite and the other analyzed as a discrete sample. The composite results from this round of sampling will be compared with the previous Phase I sampling results for assessment of the compositing method in relation to the gun and mortar positions. In addition, the individual discrete results for each depth and grid will be averaged and compared with the composite results to evaluate the effect of heterogeneity and the utility of the compositing method.

Additional soil investigations will be conducted at the remaining mortar and gun positions following the conceptual sampling approach employed in Phase I. That is, composite samples will be collected and analyzed for Phase I parameters from the firing locations and at downwind and downrange locations. Also, groundwater investigations will be performed at the four gun and mortar positions which appear to have been used the heaviest, based on rounds fired and propellant burned. The use data that are currently available indicate that these eight positions consist of GP-6 (highest propellant), GP-16 (highest rounds), GP-20



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(2<sup>nd</sup> highest propellant), GP-14 (2<sup>nd</sup> highest rounds), MP-3 (highest propellant), MP-8 (highest rounds), MP-4 (2<sup>nd</sup> highest propellant and rounds), and MP-1 (3<sup>rd</sup> highest propellant) (Ogden, 1998c).

No additional data have become available regarding firing point utilization since the Phase II (a) Workplan and Change 1 document were prepared. Therefore, the above locations for groundwater investigations are still appropriate. The locations of firing positions for gun and mortar are shown in Figure 1. A list of available coordinates for the firing positions is provided in Table 1. Table 1 also shows the priority ranking for investigation of each position, as indicated in an 8 September 1999 letter from EPA.

The CS-18 study of GP-9 (1994 and before) concluded that there is no imminent threat to human health from this site. Regulatory concerns, however, are focused on the protection of a sole source aquifer used for public drinking water. To answer all the regulatory issues, additional work is being proposed for CS-18 under the IRP prior to regulatory concurrence on site close out. The study will be conducted in 2000 and includes obtaining a more definitive characterization of soils, a current characterization of groundwater quality and groundwater movement, and preparation of an updated screening level risk evaluation for both human health and ecological receptors. The IRP recommendation for additional work or No Further Action will follow these studies.

Table 1. Coordinates for Gun and Mortar Positions (Stateplane, NAD83, Zone 4151, meters)

EPA Priority	Gun & Mortar Position ID	Easting (x-coordinates)	Northing (y-coordinates)	Area
<b>Gun Positions</b>				
19	GP-1-OLD	278105.97	825582.38	50
30	GP-2	277976.19	828752.44	51
31	GP-2-OLD	278440.22	825533.94	52
32	GP-3-OLD	278661.63	825490.38	53
14	GP-3-OLD	278848.84	826276.31	63
15	GP-4-OLD (Howe)	278648.91	826270.50	55
18	GP-4-OLD (Turpentine)	279655.70	826117.01	56
13	GP-5	278446.03	826364.63	57
9	GP-6	279237.50	826818.13	58
Phase I	GP-7	278978.31	826870.56	17
2	GP-8	278454.09	826963.06	59
IRP CS-18	GP-9	279387.97	826210.94	
3	GP-10	279232.88	826232.56	60
4	GP-11	278979.69	826244.69	61



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Table 1. Coordinates for Gun and Mortar Positions (Stateplane, NAD83, Zone 4151, meters)

EPA Priority	Gun & Mortar Position ID	Easting (x-coordinates)	Northing (y-coordinates)	Area
33	GP-12	278344.88	833265.94	62
5	GP-14	277806.72	833719.88	54
16	GP-15-OLD	278323.69	827471.75	64
Phase I	GP-16	277610.63	833662.31	16
20	GP-17	279615.41	834303.63	65
Phase I	GP-18	279418.34	834197.81	18
34	GP-19-OLD	277345.42	832756.43	66
10	GP-20	279135.94	833589.19	67
22	GP-22	280526.88	833929.94	68
25	GP-24	277073.47	828826.13	69
<b>Mortar Positions</b>				
8	MP-1	279828.22	827005.31	70
26	MP-1-OLD	278452.56	828886.38	71
27	MP-2	279325.44	827090.69	72
23	MP-2-OLD	276887.75	830391.69	73
Phase I	MP-3	278496.47	828067.13	20
24	MP-3-OLD	277113.03	831499.30	74
6	MP-4	278487.72	828367.06	75
Phase I	MP-5	278515.34	828820.69	21
Phase I	MP-6	278516.97	828877.94	20
28	MP-7	278570.22	828969.88	76
Phase I	MP-8	278507.28	829024.81	19
29	MP-9	282976.85	831031.13	77
12	Former F Range	278913.03	825575.06	78
1	Former H Range	281679.96	827699.35	79

Table 1 includes most of the known current and former firing positions for artillery and mortar, as identified in the U.S. Army Corps of Engineers (USACE) Archives Search Report (March 1999). The IBC Range and Former R Range are locations where mortar, as well as other munitions, were fired. Considering the multi-purpose nature of these ranges, investigations of these locations are being proposed through the Phase II (b) Workplans.

The remainder of this FSP provides information for field personnel engaged in soil and groundwater investigations as indicated above. The groundwater investigation consists of

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installing eight monitoring well nests at selected gun and mortar positions, as described in Section 2 below. The soil investigation initially consists of sampling GP-16 using the revised sampling approach described in Section 3 below. The soil investigation will be expanded to include other gun and mortar positions when the results from sampling GP-16 are available and have been discussed with the EPA and MADEP.

Soil sampling locations at the other gun and mortar positions are indicated in Figures 2 to 28, 31, and 32. These locations were chosen using the Phase I sampling approach of focussing on the cleared firing position, and including samples downwind and downrange of the position. The numbers of samples per position were determined based on the size of the cleared area and using a sampling density of approximately three grids per acre. The figure showing each position uses the aerial photograph for the year showing the largest apparent clearing. The aerial photos available for this FSP were from 1943, 1955, 1966, 1977, 1986, 1991, and 1994. Detailed sampling procedures for these locations will be based on the GP-16 results and will be documented in an addendum.

Sampling is also proposed at four new "control areas" as indicated in Figure 29. Control areas were defined in Phase I as areas outside the probable influence of a potential contaminant source. Control areas were sampled in Phase I to characterize a nearby "clean" area for comparison with the focal area samples. Ten control grids were included in Phase I sampling, including five for gun positions and five for mortar positions. Locations of these grids are also shown in Figure 29.

Grid BGHMAA, located at the center of GP-16, had the highest 2,4-dinitrotoluene (2,4-DNT) concentration (600 ug/kg) during Phase I sampling, and is the grid at GP-16 that is selected for initial sampling. The only sample having a higher detected explosive concentration was BGHCAA, reported to have pentaerythritol tetranitrate (PETN) present at a concentration of 36,000 ug/kg. Photo Diode Array (PDA) data for this sample were not reviewed during Phase I to confirm the results. Subsequent review of the Phase I PDA data indicates that the PETN detection was a false positive. The explosive 2,4-DNT was detected in five out of ten locations at GP-16.

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## 2.0 Installation and Sampling Methods for Monitoring Wells

The location of the monitoring well nest at each of the eight gun and mortar positions is based on the layout of each site in relation to the direction of groundwater flow. The monitoring well nest will be placed on the downgradient edge of each site to maximize the probability of detecting a contaminant if it originates from within the gun and mortar position. One well at each site will be screened at the water table to assess any impacts to groundwater from the gun and mortar positions. Additional well screens may be placed at each location based on groundwater profile sample results. A map showing the eight gun and mortar positions where well nests will be installed is provided in Figure 30. The previous maps showing soil sampling locations at each gun and mortar position also show well locations at the positions where wells have been proposed (see Figures 8, 13, 17, 20, 25, and 26). Figure 31 shows the proposed monitoring well location at Mortar Position 3, which has already had soil samples collected during Phase I of the IAGS.

Downgradient offsite wells reportedly exist for GP-14 and GP-16, located in the northwest corner of MMR. The locations and depths of these wells will be determined and evaluated for use in evaluating groundwater quality emanating from the gun positions.

Monitoring wells will be installed per the Final FSP for Barber Rig Drilling Investigation (Ogden, 1997b) as well as Section 4 of the Action Plan (ETA, 1997). Each boring will have downhole UXO clearance. Soil lithology will be logged using cuttings from the cyclone. Sample collection will be consistent with MMR SOPs and the Ogden Health and Safety Guidelines.

Groundwater profile samples will be collected as close as possible to the water table and every ten feet below the water table, during advancement of the borings. Each boring will be extended approximately 150 feet below water table. Estimated water table depth at each proposed well location is indicated in Table 2. Profile samples will be collected in accordance with Sampling Protocol C.2, outlined in Section 4.2.2 of the Action Plan (ETA, 1997). Profile samples will be submitted for laboratory analysis of explosives (EPA Method 8330, specify 1-day rush) and VOCs (CLP Method OC21V, specify 1-day rush). Once the monitoring well is completed and developed it will be sampled for the complete analyte suite used during Phase I.



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Table 2. Estimated Water Table Depths for Gun/Mortar Position Borings

Gun or Mortar Position	Proposed Monitoring Well	Estimated Water Table Depth (ft bgs)
GP-6	MW-64	90
GP-14	MW-65	117
GP-16	MW-66	107
GP-20	MW-67	158
MP-1	MW-68	90
MP-3	MW-69	62
MP-4	MW-70	194
MP-8	MW-71	174

### 3.0 Sampling & Analysis Methods for Soils

Grid GHM at GP-16 will be resampled using a 30 x 30-foot nine-point sampling grid as it was in Phase I, and also overlaid with two five-point grids, each measuring 22 x 22 feet. Sampling points for the five-point grids are illustrated in Figure 33, and the proposed overlay orientation at grid GHM is shown in Figure 34. Each five-point grid will have all five subsamples separately homogenized and split into two subsamples, one used for the grid composite and the other analyzed as a discrete sample. The sampling intervals will be 0-6 and 18-24 inches bgs. Additional sampling at depth will be dependent upon the results of the surface soil samples and will be discussed with the USEPA and MADEP on a case by case basis. Soil subsamples will be wetted using deionized water as needed to prevent observable dust emissions during the composite mixing process.

Sample collection will be consistent with MMR SOPs, the Ogden Health and Safety Guidelines, Attachment A: Field guide to High Explosives, and the ASTM Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Sampling grids will be flagged for magnetic anomalies prior to sampling, and sampling points adjusted if necessary to avoid anomalies. EPA Method 8330 will be used to analyze all samples.

The following protocol will be followed for sampling at GP-16:

1. A 0-6" soil sample will be collected from each of the five sample points in a grid, resulting in five subsamples per grid;
2. Each subsample will be homogenized (wetting as needed to prevent dust emission)

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- and split into two subsamples in accordance with Section 8.1 of the ASTM Standard Guide and Attachment A of this FSP, resulting in five pairs of subsamples;
3. One of the two splits from each point will be combined with the other splits in the grid to comprise a single composite sample, in accordance with Section 8.1 of the EPA Standard Guide and Attachment A of this FSP, resulting in five discrete subsamples and one composite subsample;
  4. Repeat steps 2-3 above for the 18-24" depth interval for each grid.

Soil sampling at the other gun and mortar positions will be completed using five-point grids, each measuring 22 x 22 feet. Sampling points for the five-point grids are illustrated in Figure 33. Each five-point grid will have all five subsamples homogenized and analyzed as a composite sample, except for the VOC analysis. The sampling intervals will be 0-6 and 18-24 inches bgs. Additional sampling at depth will be dependent upon the results of the surface soil samples and will be discussed with the USEPA and MADEP on a case by case basis. Soil subsamples will be wetted using deionized water as needed to prevent observable dust emissions during the composite mixing process.

Sample collection will be consistent with MMR SOPs, the Ogden Health and Safety Guidelines, Attachment A: Field guide to High Explosives, and the ASTM Standard Guide for Composite Sampling and Field Subsampling for Environmental Waste Management Activities (October 31, 1996). Sampling grids will be flagged for magnetic anomalies prior to sampling, and sampling points adjusted if necessary to avoid anomalies. Samples will be analyzed for all Phase I analytes.

The following protocol will be followed for sampling each of the five points in a grid:

- The split barrel sampler will be decontaminated following the procedures outlined in SOP "MMR TECH-036".
- The split barrel sampler will be hammered to the desired depth using the slide hammer.
- The sampler will be retracted from the hole and detached from the hammer.
- The core tip and hammer cap will be unscrewed from the split tube.
- The split tube will be opened and samples will be transferred to a headspace container and a decontaminated stainless steel bowl for preparation of composite samples.
- The split barrel sampler will be decontaminated prior to the collection of additional samples.

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- If refusal is encountered with the split barrel sampler, an attempt to collect the sample with a hand auger will be made.
- The split barrel sampler will be used for the collection of laboratory samples only. If there is an interval in the boring that will not be laboratory analyzed, then that interval will be removed using a decontaminated hand auger.

### Volatile Organic Compound Sampling

The location for VOC sampling within the grid will be selected based on headspace measurements. After the soil from the desired interval has been collected as described above, the following procedure will be followed for VOC samples:

- Soil samples shall be collected using an open barrel, disposable syringe
- The syringe will be filled with approximately 5 grams of relatively undisturbed soil.
- The soil will be extruded into a tared, prepreserved VOA vial containing a stir bar, sodium bisulfate and distilled water. (These tared VOA vials are provided by the manufacturer).
- The VOA vial will be capped quickly and label with EPA IDs, date, and time of collection.
- Three VOA vials will be collected for each sampling location for analysis by Method OLM03.2 and three VOA vials for Method 8021 (MTBE and EDB).
- In the event that a field screening technique (instrument reading, visual staining of the soil, or olfactory observation) indicates the presence of VOCs or hydrocarbons, note the observations or instrument readings in the field logs. The sample shall be recollected following receipt of the laboratory results that indicate volatiles exceeding 200ppb (indicating a high level volatile analysis).
- If the sample is collected for high level volatile analysis, the sampling procedure will be the same with the exception that the sample shall be extruded into a VOA vial containing "Purge and Trap" grade methanol. (The VOA vials preserved with methanol shall be supplied by the laboratory as needed).
- DOT requirements for the shipping of methanol will be followed.

In addition to field samples, QA/QC samples will be collected as described in the QA/QC Plan (Ogden, 1999b). These include field duplicates at the rate of 10% (rounded to the next whole number) of the field samples, trip blanks at the rate of 1 per shipping cooler containing VOC samples, field blanks at the rate of one per sampling event per water source, and equipment rinsates at the rate of 1 per day per decontamination method.



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## 4.0 Sample Identification

### 4.1 Groundwater Profile Samples

Profiling samples will be uniquely identified with an Ogden sample ID that contains a reference to the sample location (well number) and the sample depth. The following is an example of the sample ID:

GP0064M1A

The sample ID is broken down in the following example, to describe each of the components:

GP - 0064 - AA - A

- GP Indicates that the sample being collected is a groundwater profiling sample.
- 0064 Indicates the boring number from which the sample was collected.
- AA Indicates the depth from which the sample was collected. Leading letter "A" will indicate the first groundwater sample collected from the water table or immediately below the water table. Each subsequent 10-foot interval, will be the next consecutive letter. For instance a sample from 30 feet below the water table would be designated using "DA". If water cannot be recovered from a sample interval, the letter to designate that interval is not used. If water is collected from the next 10-foot interval, the next consecutive letter would be used.
- A Indicates the type of sample.
  - A Original Sample
  - D Duplicate Sample
  - E Equipment Rinsate
  - F Field Blank
  - T Trip Blank

For example, GP0064MAD is a groundwater profiling duplicate sample from MW-64, from 120' below water table.

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## 4.2 Soil Samples

Soil samples may be collected from borings depending on PID field screening results. Samples will be uniquely identified with an Ogden sample ID similar to the above for groundwater profile samples, except that the first two characters are "SB" rather than "GP". Also, the depth character will be "AA" for the first sample (regardless of depth), "BA" for the second sample, etc.

Soil samples from grids collected by hand auger will be uniquely identified with an Ogden sample ID similar to the above for groundwater profile samples, except that the first two characters are "HC" for composite samples and "HD" for discrete samples. The 4-digit boring number is entered as follows:

- The first two digits are the area number = 16 for GP-16
- The next character denotes grid location = "O" and "P" as indicated in Figure 9
- The next digit denotes subsample location = 1 for composite sample and 1-5 for discrete samples (label on boring log)

The 2-character depth designation is similar to the above for groundwater profile samples, where "AA" is the first depth (0-3 inches bgs), "BA" is the second depth (3-6 inches bgs), and "CA" is the third depth (6-12 inches bgs).

## 5.0 References

ETA, 1997. Final Action Plan for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Engineering Technologies Associates, Inc., Ellicott City MD, July 1997.

Ogden, 1997a. Final Field Sampling Plan for Rotosonic Rig Drilling Investigation of the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, July 18, 1997.

Ogden, 1997b. Final Field Sampling Plan for Barber Rig Drilling Investigation of the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, July 18, 1997.

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Ogden, 1998a. Workplan for Phase II (a) Activities for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 11/12/98.

Ogden, 1998b. Draft Completion of Work Report for the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 7/1/98.

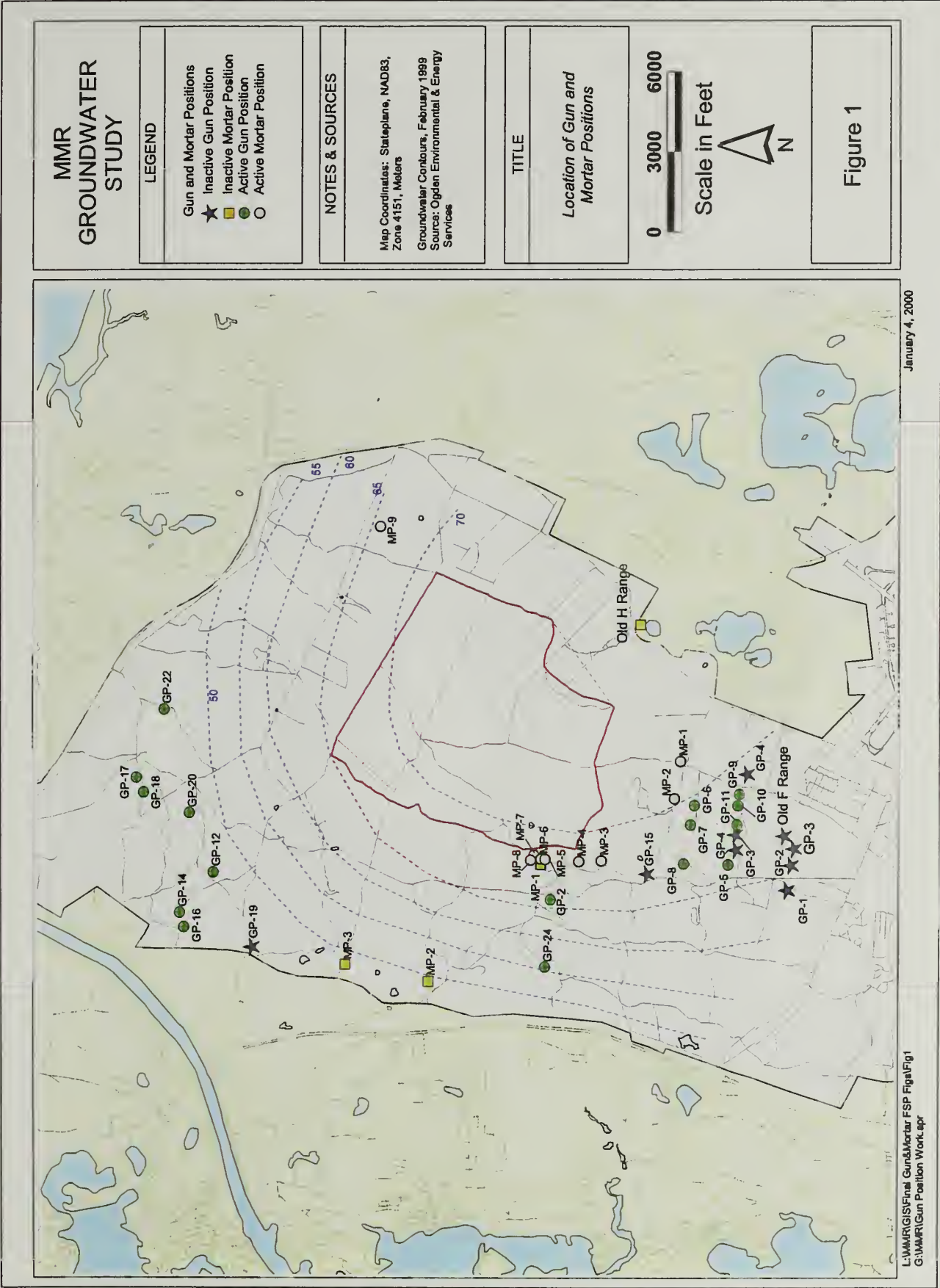
Ogden, 1998c. Final Field Sampling Plan for Gun and Mortar Positions of the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 02/09/98.

Ogden, 1999a. Change 1 to the Workplan for Phase II (a) Activities dated 11/12/98. Attachment to letter of February 8, 1999 from Ogden Environmental and Energy Services to USEPA.

Ogden, 1999b. Quality Assurance/Quality Control Plan Addendum of the Camp Edwards Impact Area Groundwater Quality Study. Prepared for the National Guard Bureau, Arlington VA, by Ogden Environmental and Energy Services, Westford MA, 04/14/99.



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# Final Phase II (a) Gun/Mortar FSP

## MMR GROUNDWATER STUDY

### LEGEND

- Proposed Soil Sample Grids
- Proposed Monitoring Well
- Existing Monitoring Wells
- Topography (3 meter contours)

### NOTES & SOURCES

Map Coordinates: Stateplane, NAD83,  
Zone 4185, Meters  
Aerial photography: 1:8000 digital  
black & white aerial photography.  
Source: MASSGIS  
Date From: December, 1977  
Topography: 3 meter contours  
generated from digital terrain models (DTMs)  
Source: MASSGIS

### TITLE

Proposed Soil Sample  
Grid Locations For Old  
Gun Position 1

0 200 400 600

Scale in Feet



Figure 2

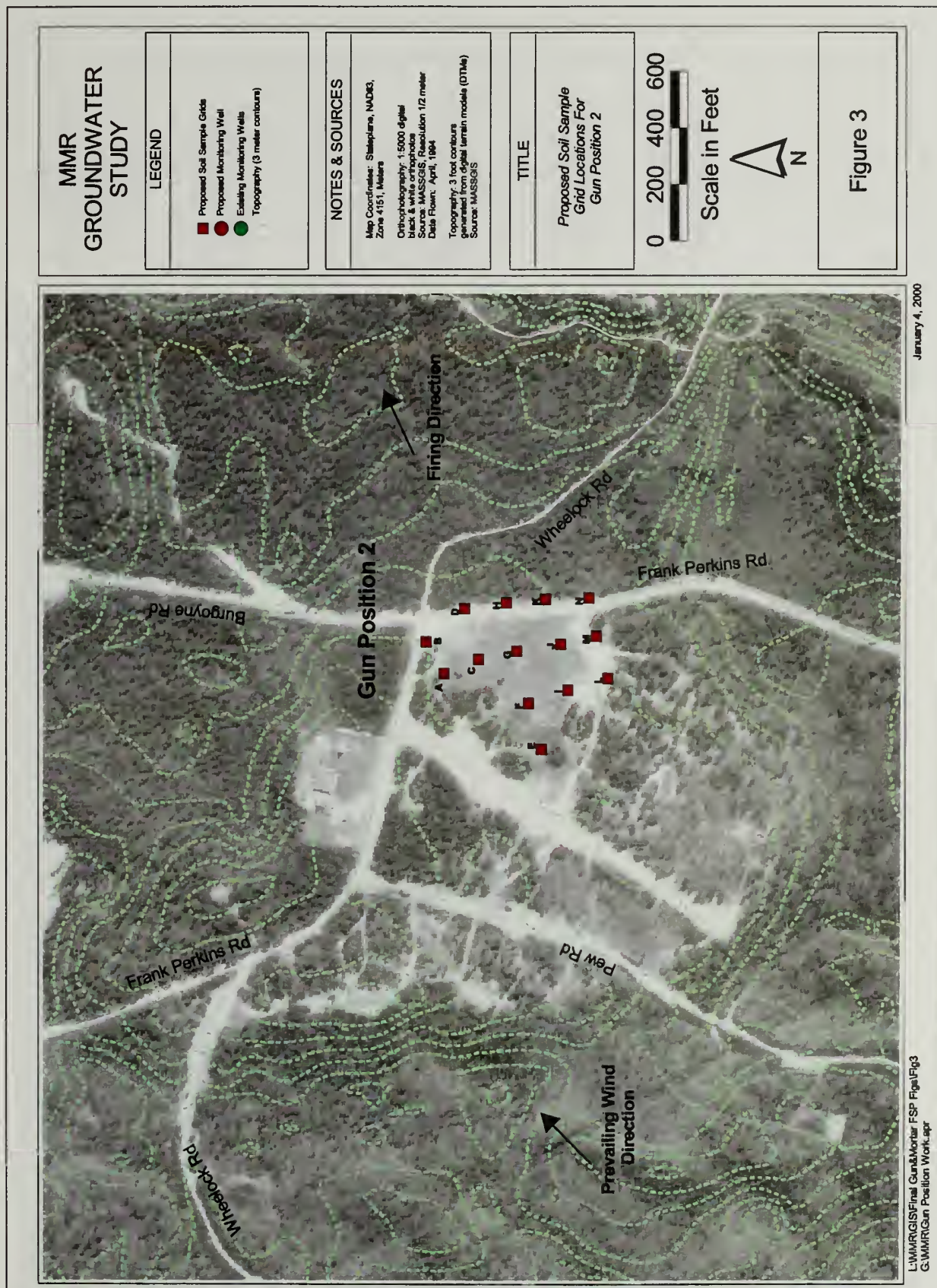


January 4, 2000

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G:\MMRGIS\Gun Position Work\...





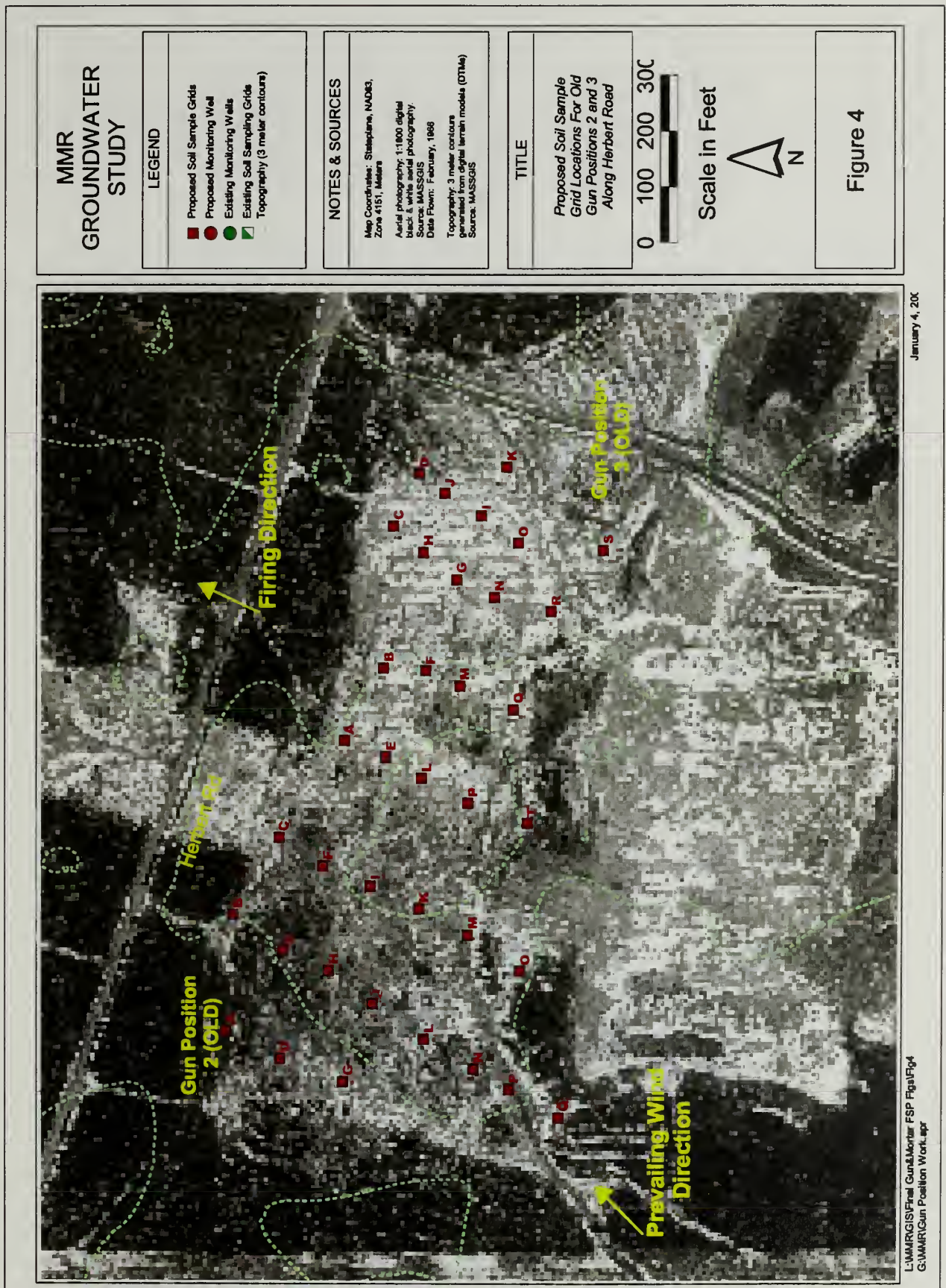


January 4, 2000



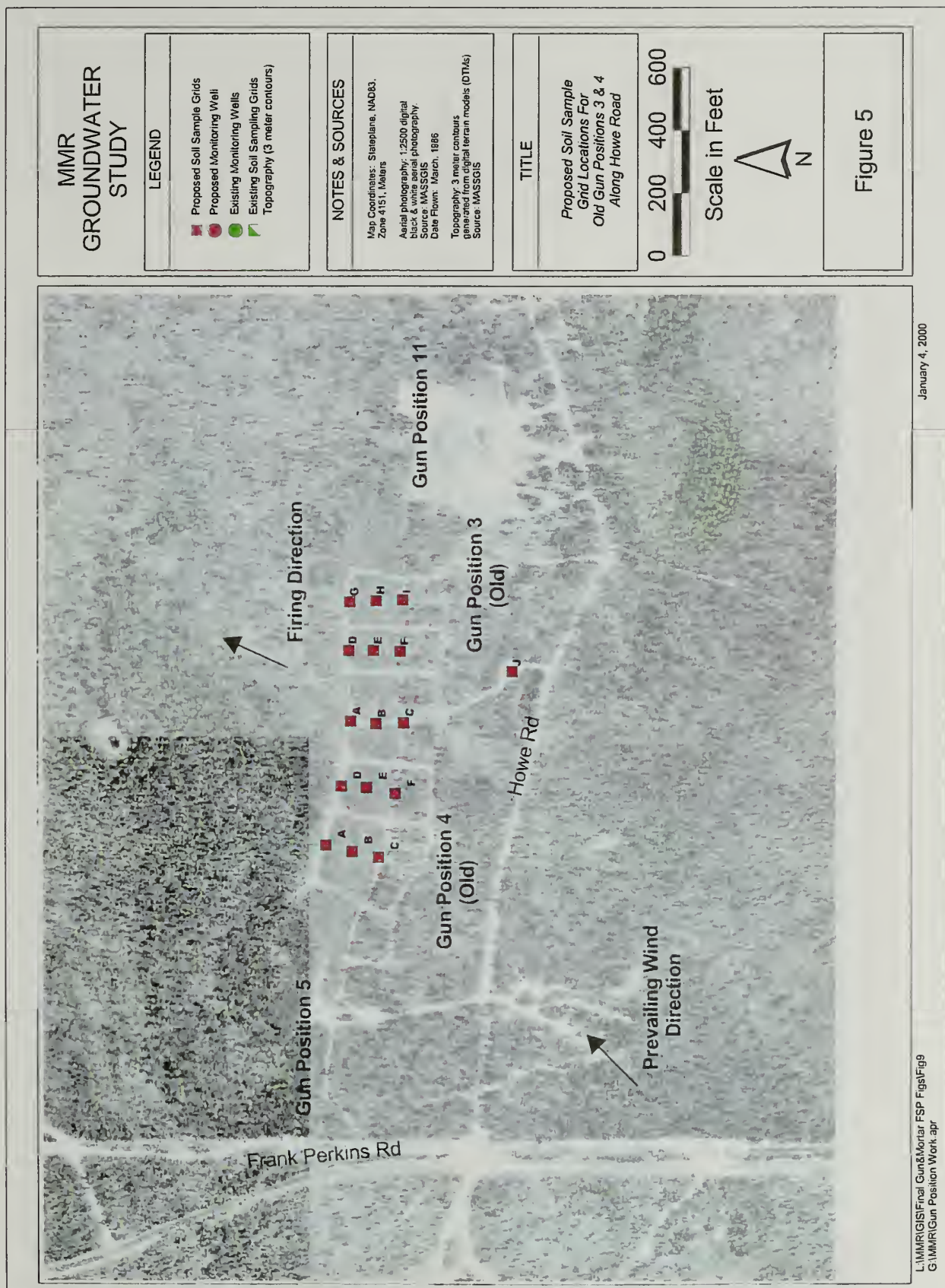


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January 4, 2000

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G:\MMR\Gun Position Work.apr





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## MMR GROUNDWATER STUDY

### LEGEND

- Proposed Soil Sample Grids
- Proposed Monitoring Well
- Existing Monitoring Wells
- Topography (3 meter contours)

### NOTES & SOURCES

Map Coordinates: Stateplane, NAD83,  
Zone 4161, Meters  
Aerial photography: 1:2000 digital  
National Aerial Photography  
Source: MASSGIS  
Date Flown: February, 1995  
Topography: 3 meter contours  
generated from digital terrain module (DTM)  
Source: MASSGIS

### TITLE

Proposed Soil Sample  
Grid Locations For Old  
Gun Position 4 Off  
Of Turpentine Road

0 200 400 600

Scale in Feet



Figure 6



January 4, 2000

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G:\MMR\Gun Position Work.apr

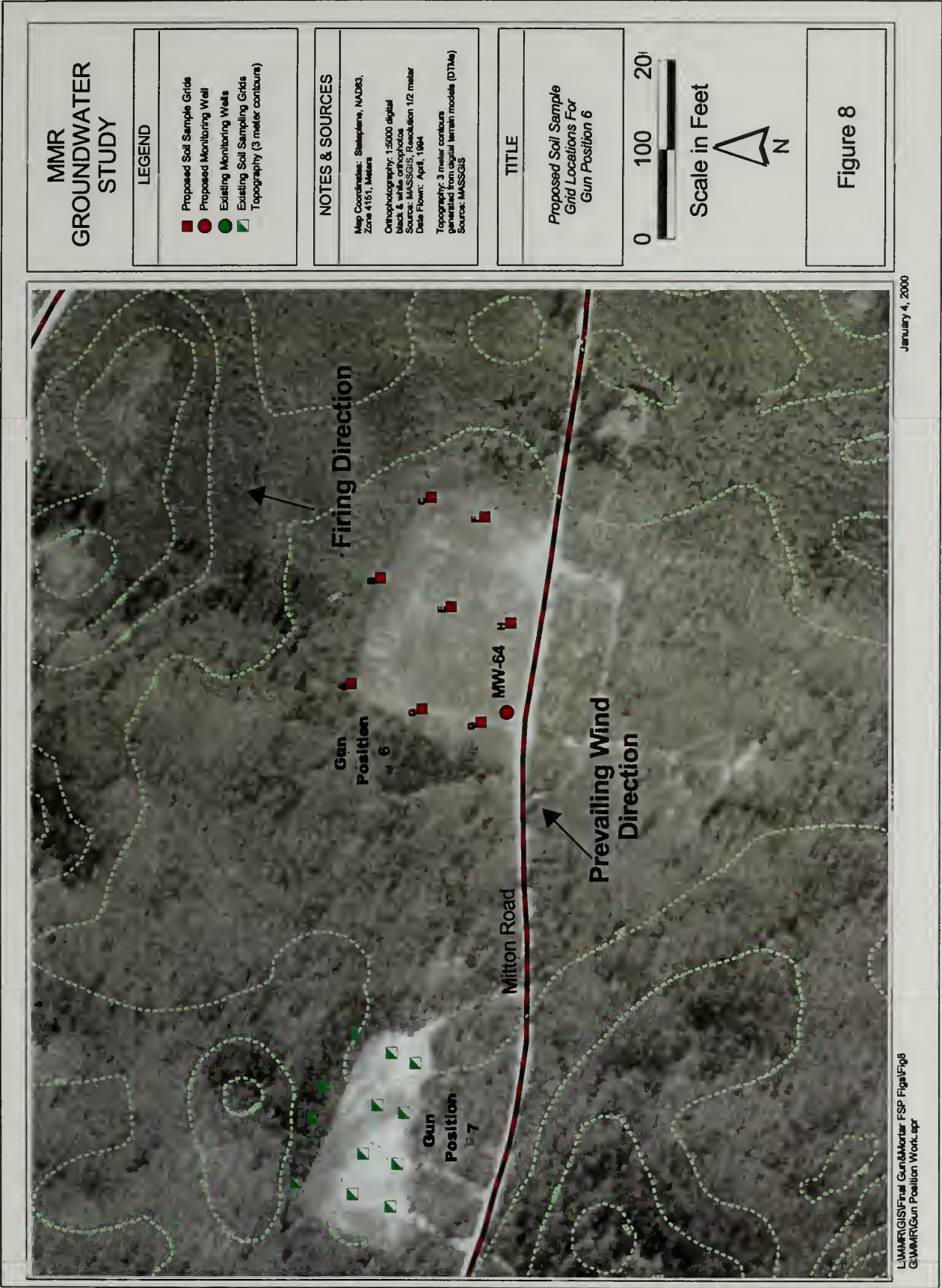














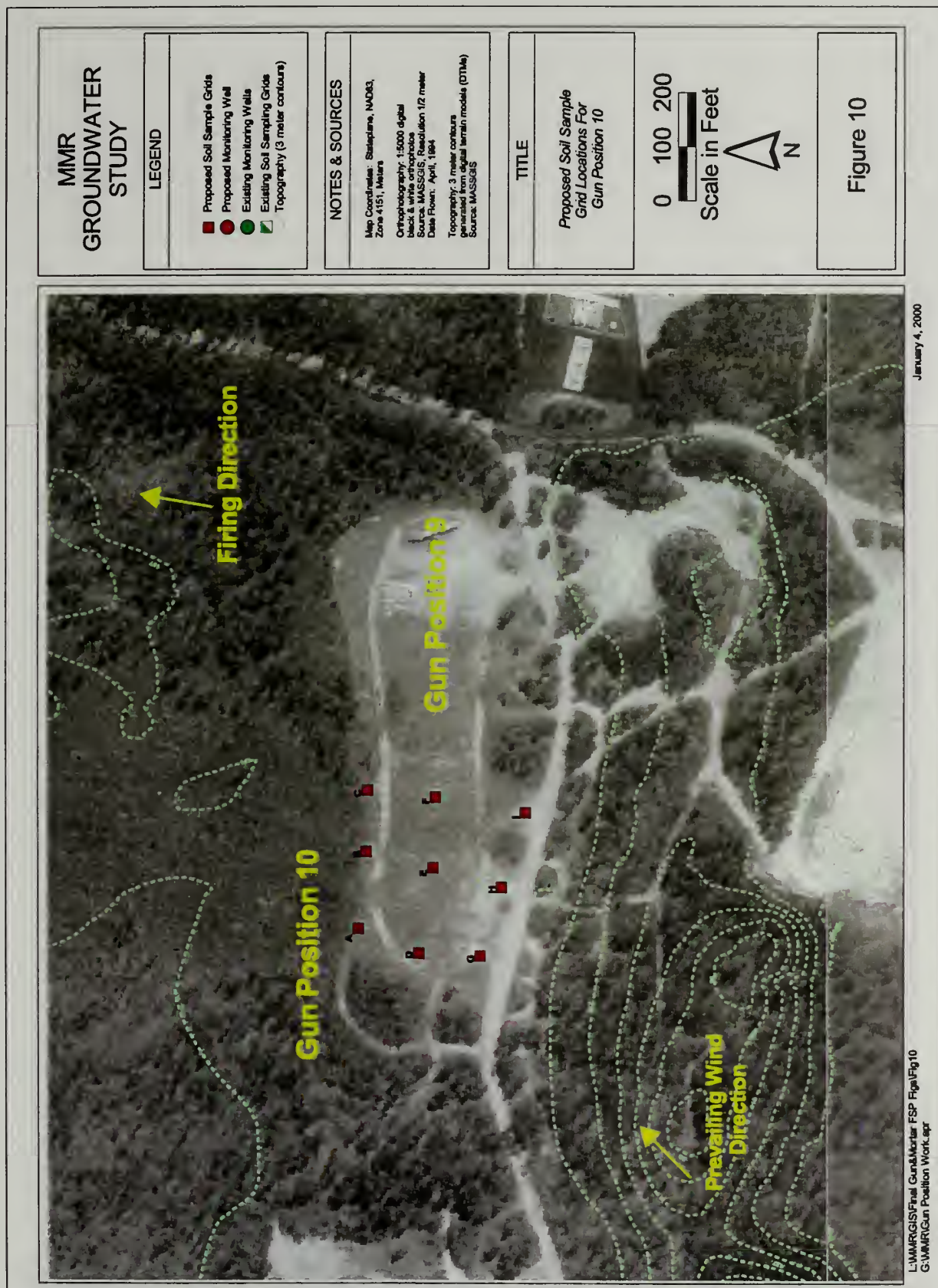


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## MMR GROUNDWATER STUDY

### LEGEND

- Proposed Soil Sample Grids
- Proposed Monitoring Well
- Existing Monitoring Wells
- Existing Soil Sampling Grids
- Topography (3 meter contours)

### NOTES & SOURCES

Map Coordinates: Stateplane, NAD83,  
Zone 4161, Meters  
Orthophotography: 1:5000 digital  
black & white orthophotos  
Source: MASSGIS; Resolution 12 meter  
Date Flown: April, 1994  
Topography: 3 meter contours  
generated from digital terrain models (DTMs)  
Source: MASSGIS

### TITLE

Proposed Soil Sample  
Grid Locations For  
Gun Position 11

0 80 160  
Scale in Feet



Figure 11



January 4, 2000

L:\MMR\GIS\Final Gun&Mortar FSP Fig\Fig11  
G:\MMR\Gun Position Work.apr





# Final Phase II (a) Gun/Mortar FSP



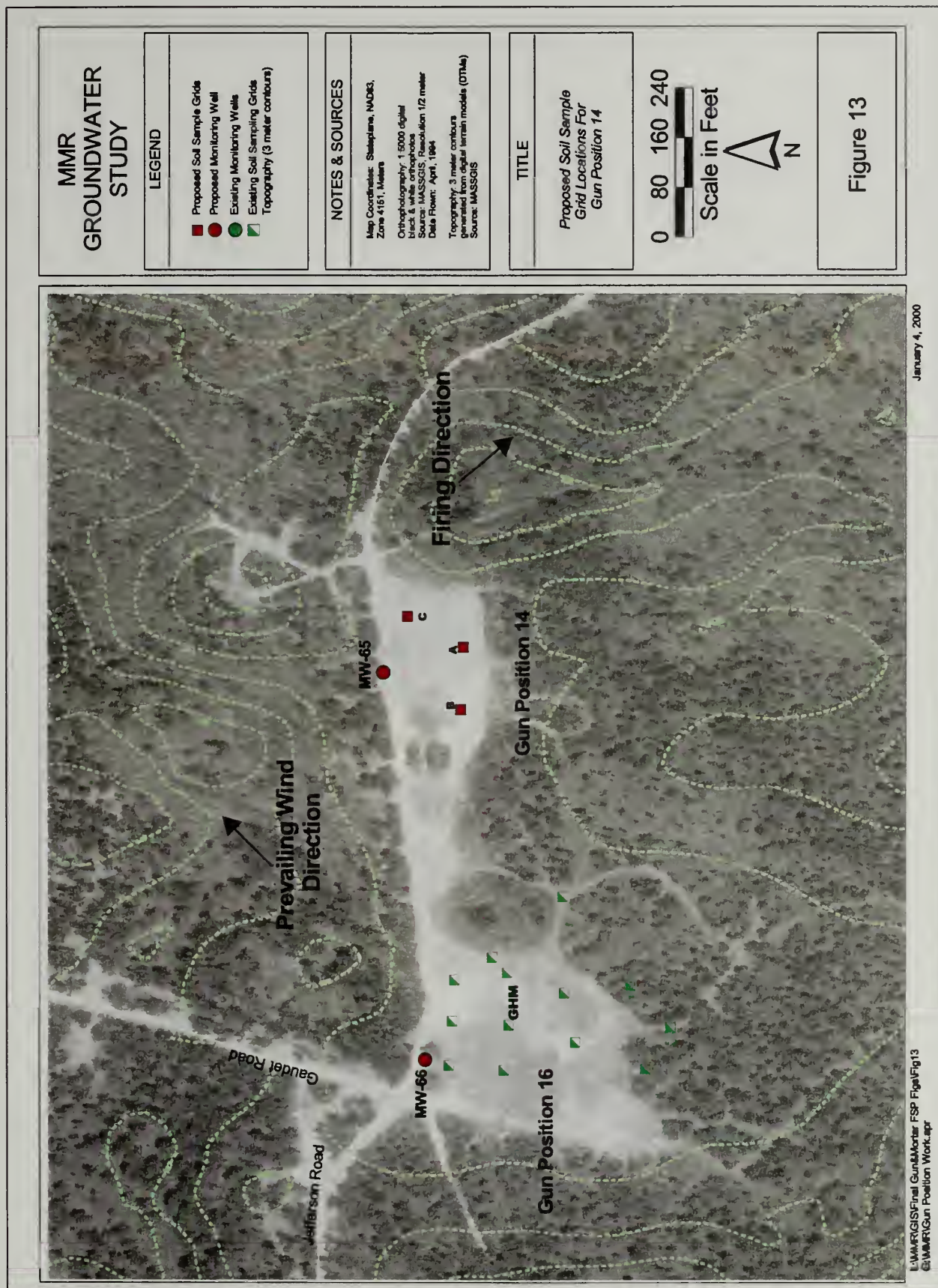
The figure is a topographic map of a rural area. It features several roads: Burke Rd running diagonally from the top left to the bottom right, Cat Rd running horizontally across the middle, and Jefferson Rd running diagonally from the bottom left to the top right. The terrain is depicted with green contour lines indicating elevation. At the center of the map, near the intersection of Burke Rd and Cat Rd, is 'Gun Position 12'. This position is marked with a red square and labeled 'c'. To the right of the gun position, an arrow points towards the top right, labeled 'Firing Direction'. To the left of the gun position, an arrow points towards the bottom left, labeled 'Prevailing Wind Direction'. The map also shows some smaller features like a 'Cat Rd' label near the bottom left and a 'Burke Rd' label near the top left.

L:\MMR\GIS\Final Gun&Mortar FSP Fig\Fig12

G:\MMR\Gun Position Work.apr











Final Phase II (a) Gun/Mortar FSP

MMR  
GROUNDWATER  
STUDY

LEGEND

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Proposed Soil Sample Grids

●

Proposed Monitoring Well

●

Existing Monitoring Wells

●

Existing Soil Sampling Grids

—

Topography (3 meter contours)

NOTES & SOURCES

Map Coordinates: Stateplane, NAD83,  
Zone 4151, Meters

Aerial Photography: 1:1800 digital  
black & white aerial photographs  
Source: MASSGIS  
Data Point: December, 1977

Topography: 3 meter contours  
generated from digital terrain model (DTM)  
Source: MASSGIS

TITLE

Proposed Soil Sample  
Grid Locations For Old  
Gun Position 15

0 80 160 240

Scale in Feet

N

Figure 14

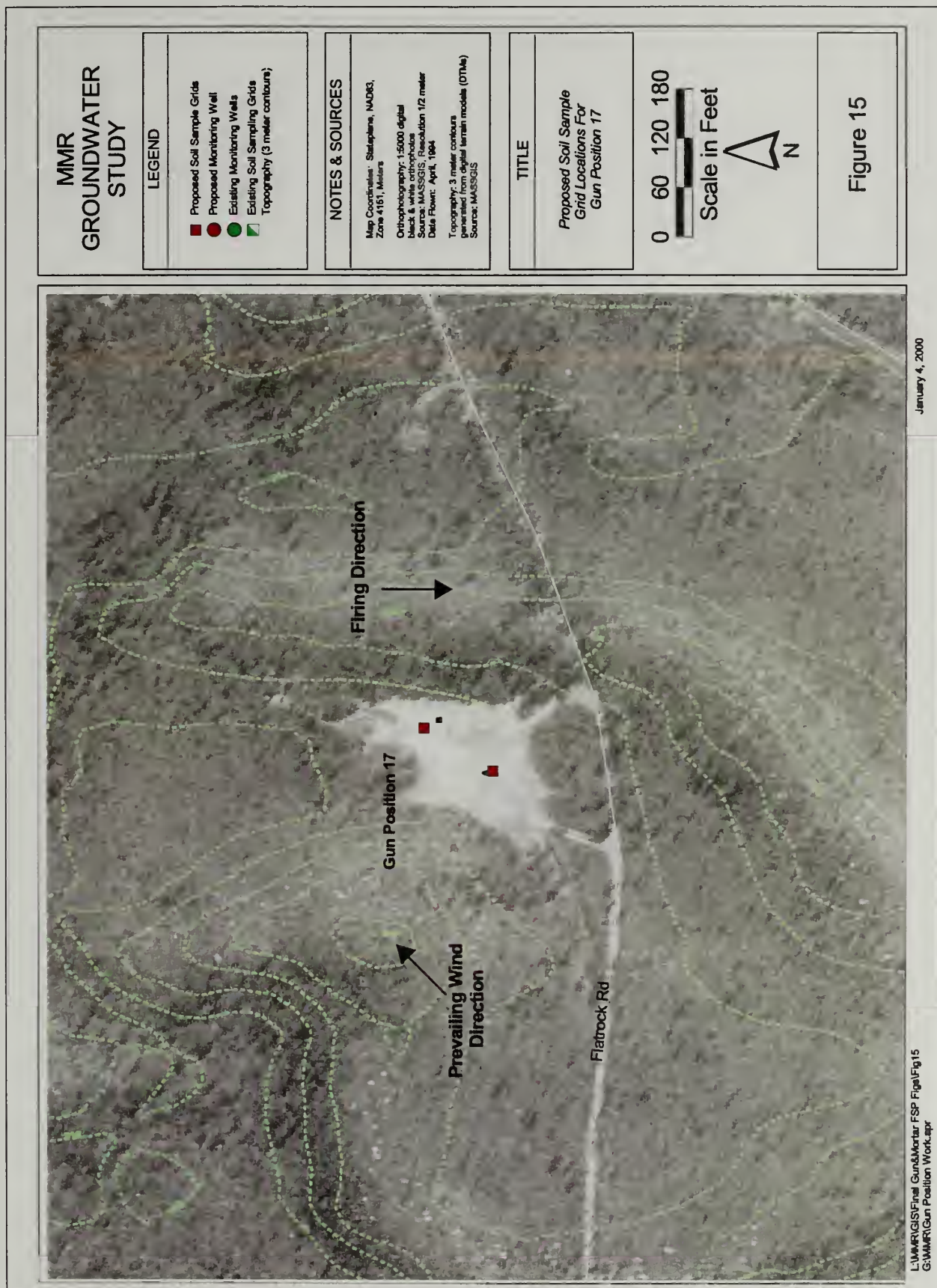


January 04, 2000

L:\MMRGSP\Final Gun&Mortar FSP Figs\Fig14  
G:\MMRG\Gun Position Work.apr



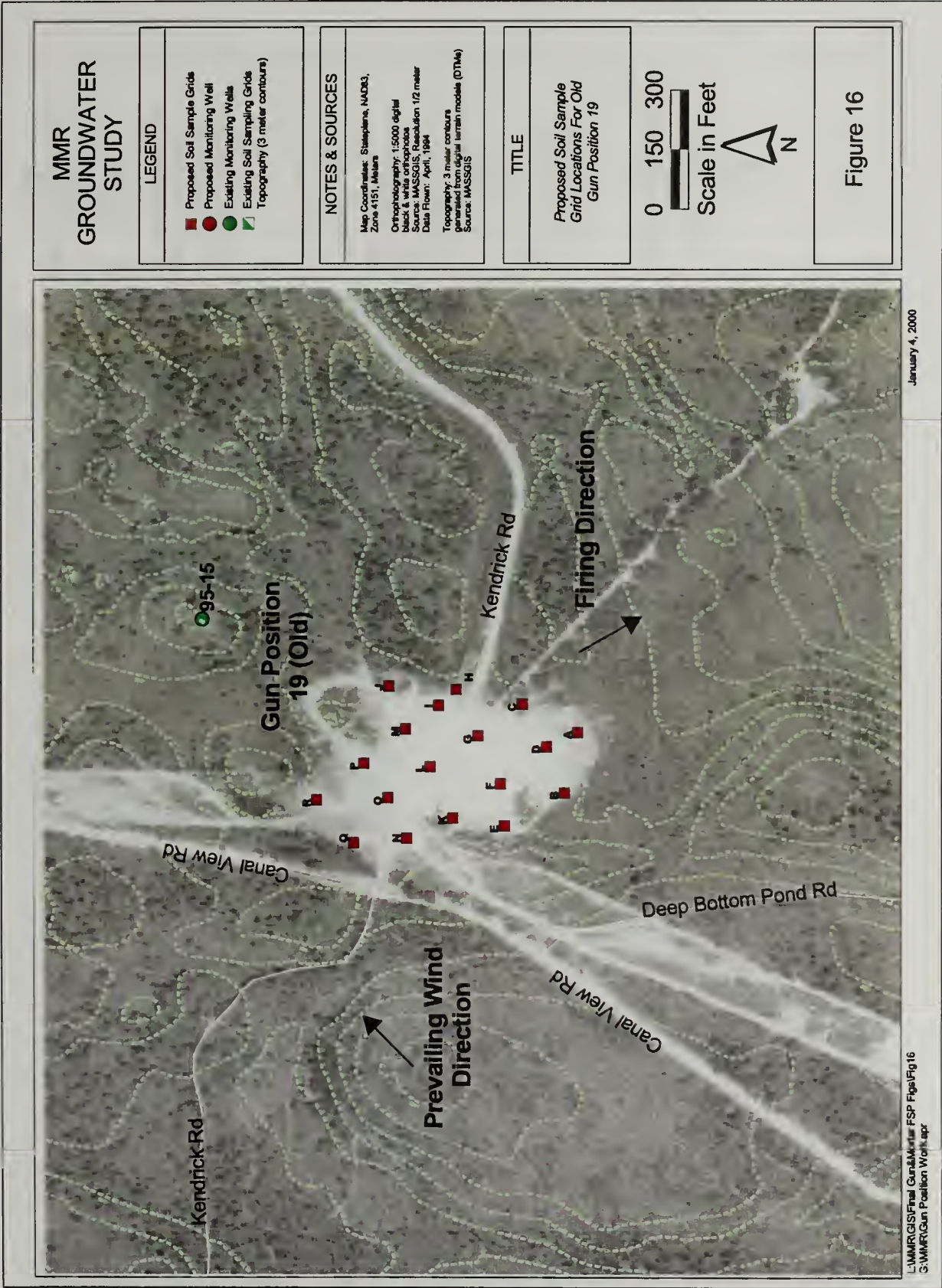
# Final Phase II (a) Gun/Mortar FSP







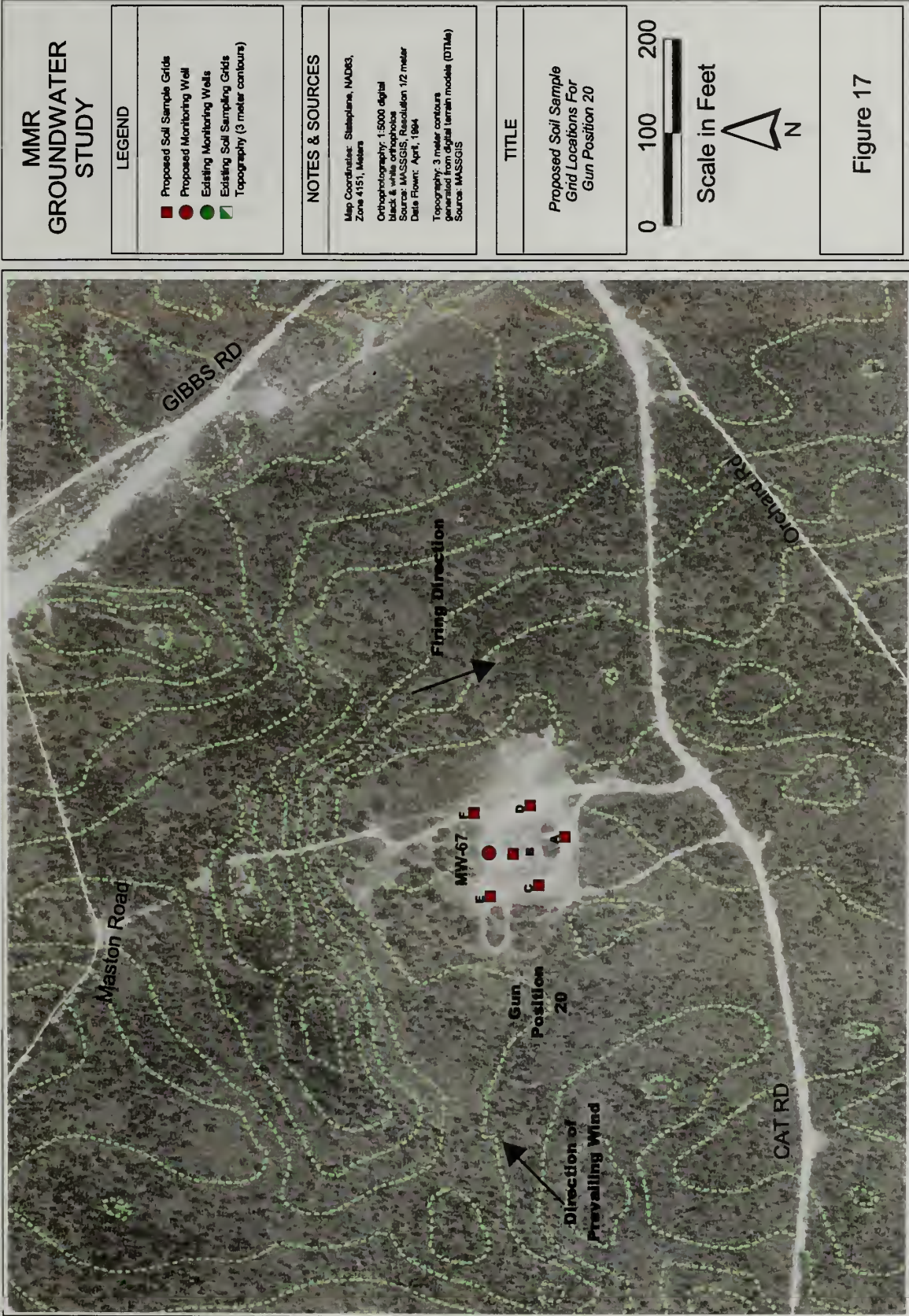








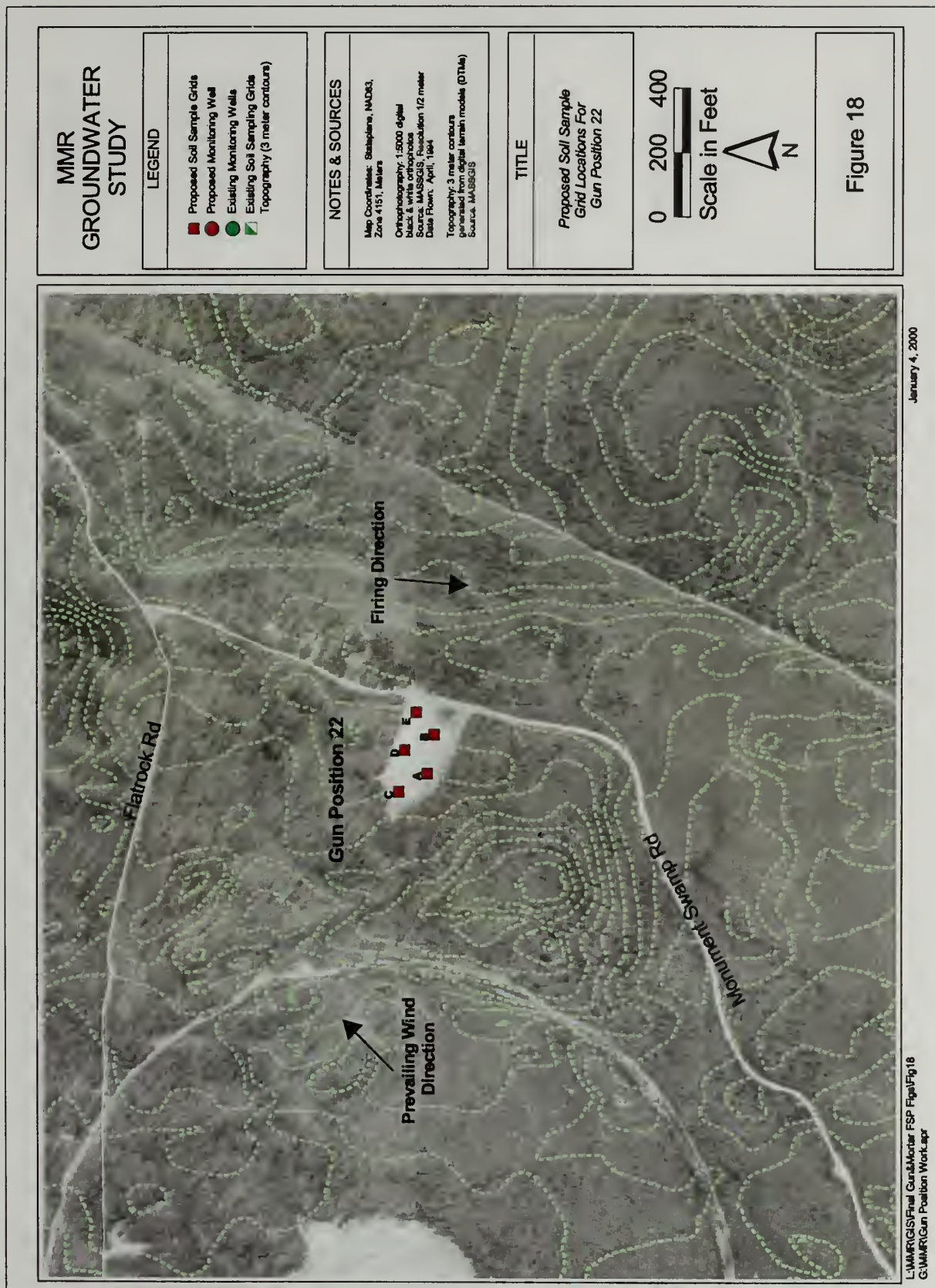
# Final Phase II (a) Gun/Mortar FSP







# Final Phase II (a) Gun/Mortar FSP



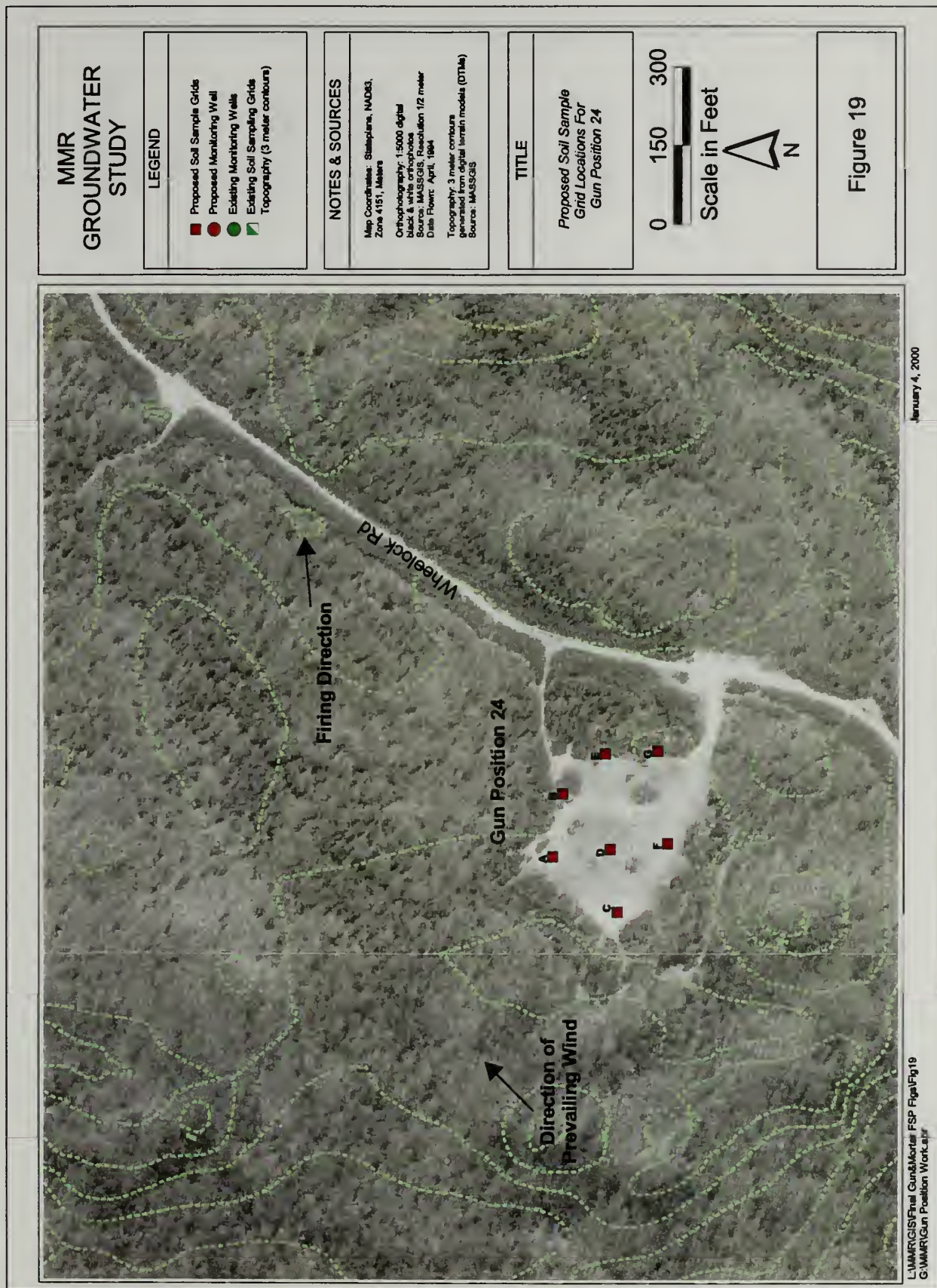
L:\MMR\GIS\Final Gun&Mortar FSP Fig\Fig 18  
G:\MMR\Gun Position Work\apr

January 4, 2000





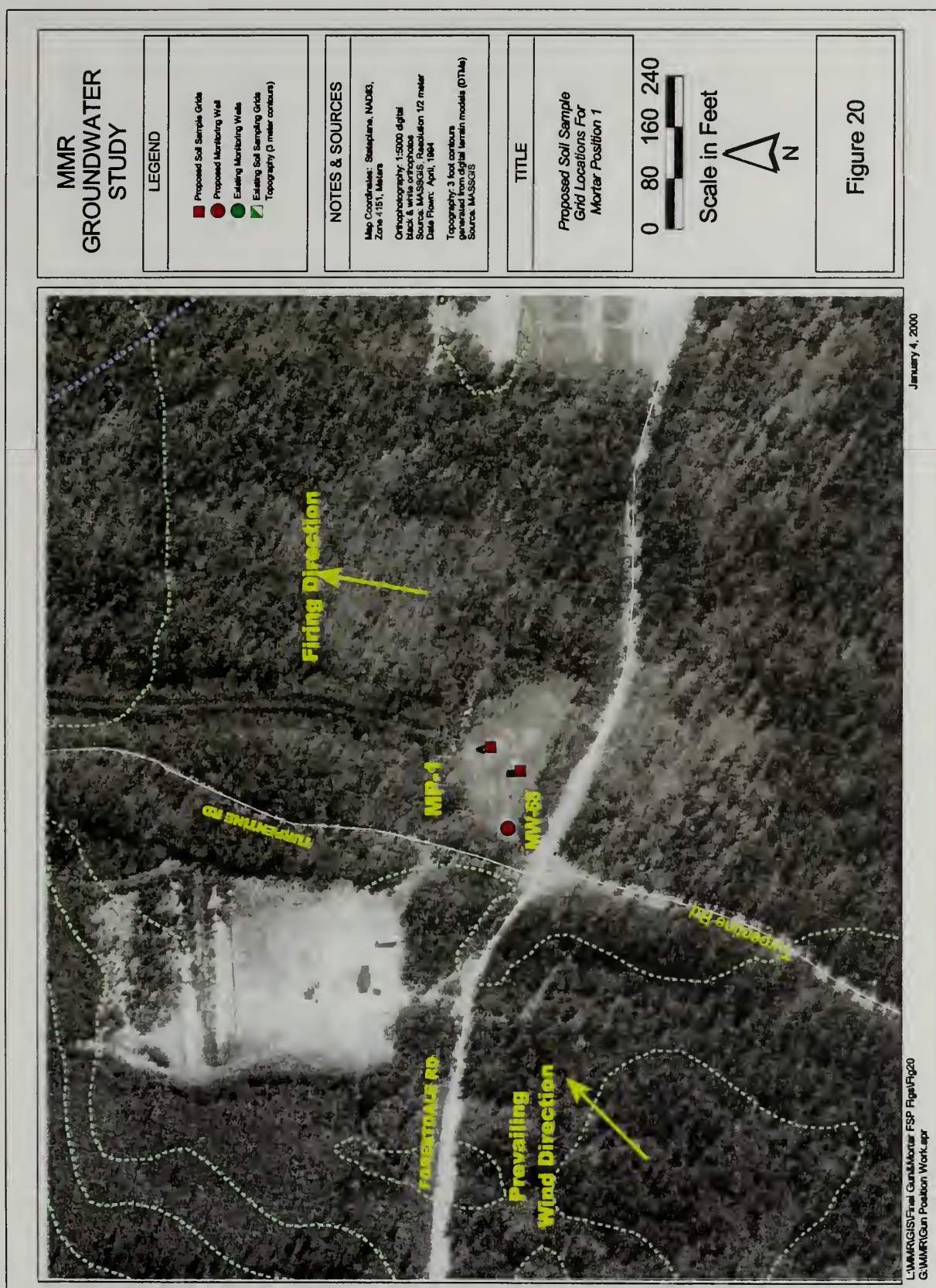
# Final Phase II (a) Gun/Mortar FSP







# Final Phase II (a) Gun/Mortar FSP







Final Phase II (a) Gun/Mortar FSP

MMR  
GROUNDWATER  
STUDY

LEGEND

Proposed Soil Sample Grids

Proposed Monitoring Wells

Existing Monitoring Wells

Existing Soil Sampling Grids

Topography (3 meter contours)

NOTES & SOURCES

Map Coordinates: Stateplane, NAD83, Zone 4151, Meters

Orthorectification: 15000 digital black & white composites

Source: MASSGIS, Resolution 12 meter

Date Flown: March, 1998

Topography: 3 foot contours generated from digital terrain models (DTM)

Source: MASSGIS

TITLE

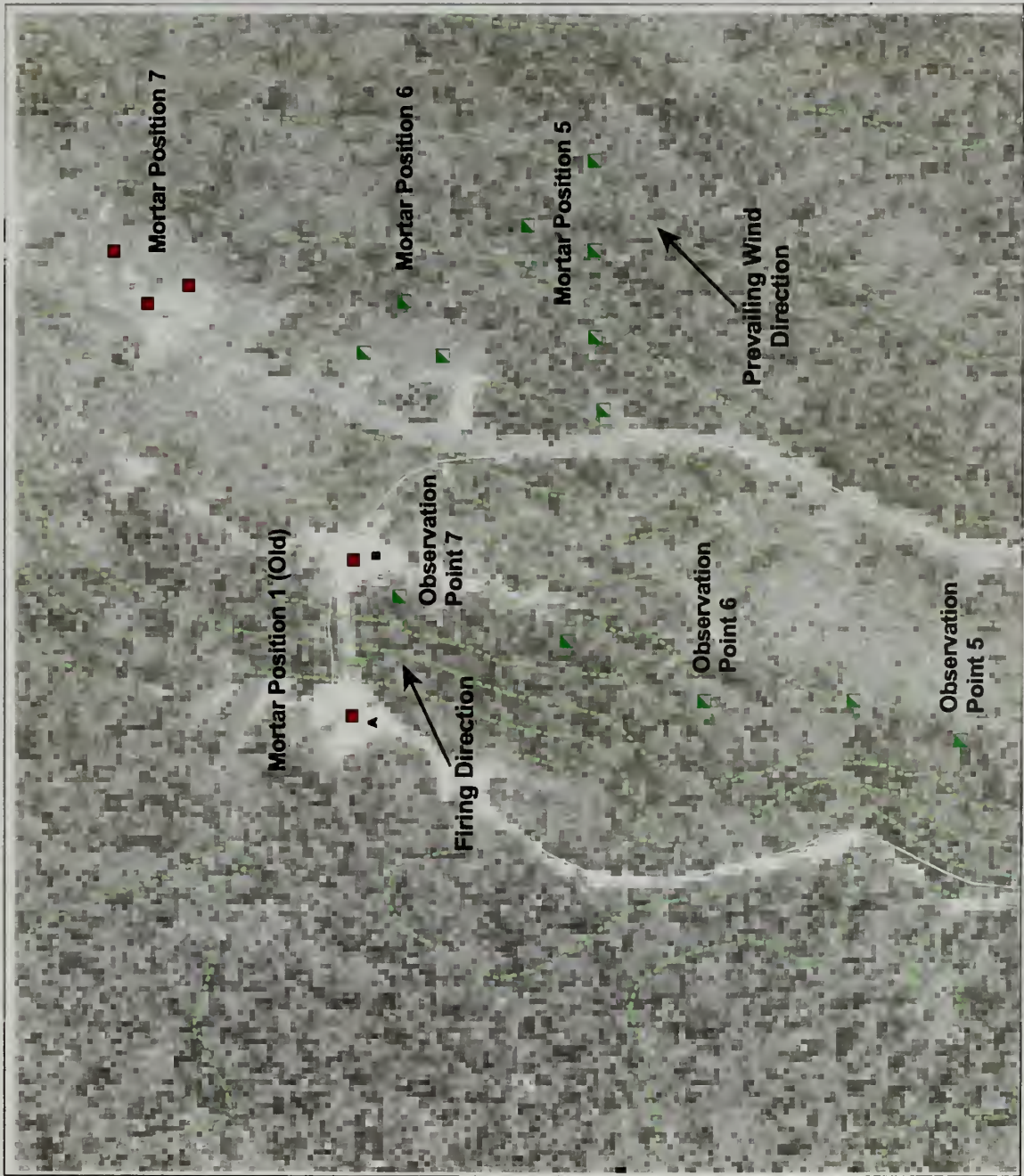
Proposed Soil Sample Grid Locations For Old Mortar Position 1

0 60 120 180

Scale in Feet

N

Figure 21

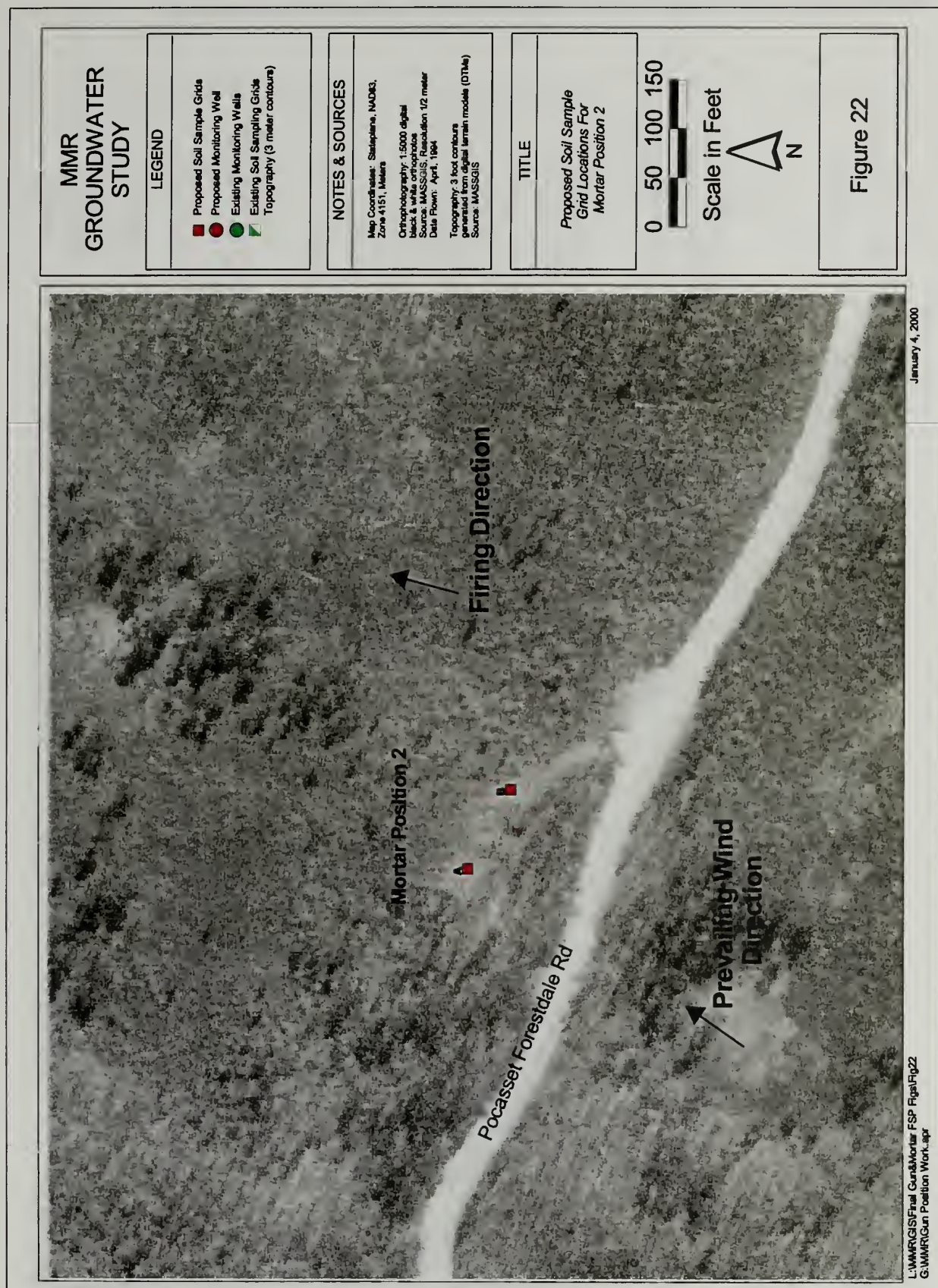


January 4, 2000

L:\MMRGIS\Final Gun&Mortar FSP Figs\Fig21  
G:\MMRGun Position Work.apr



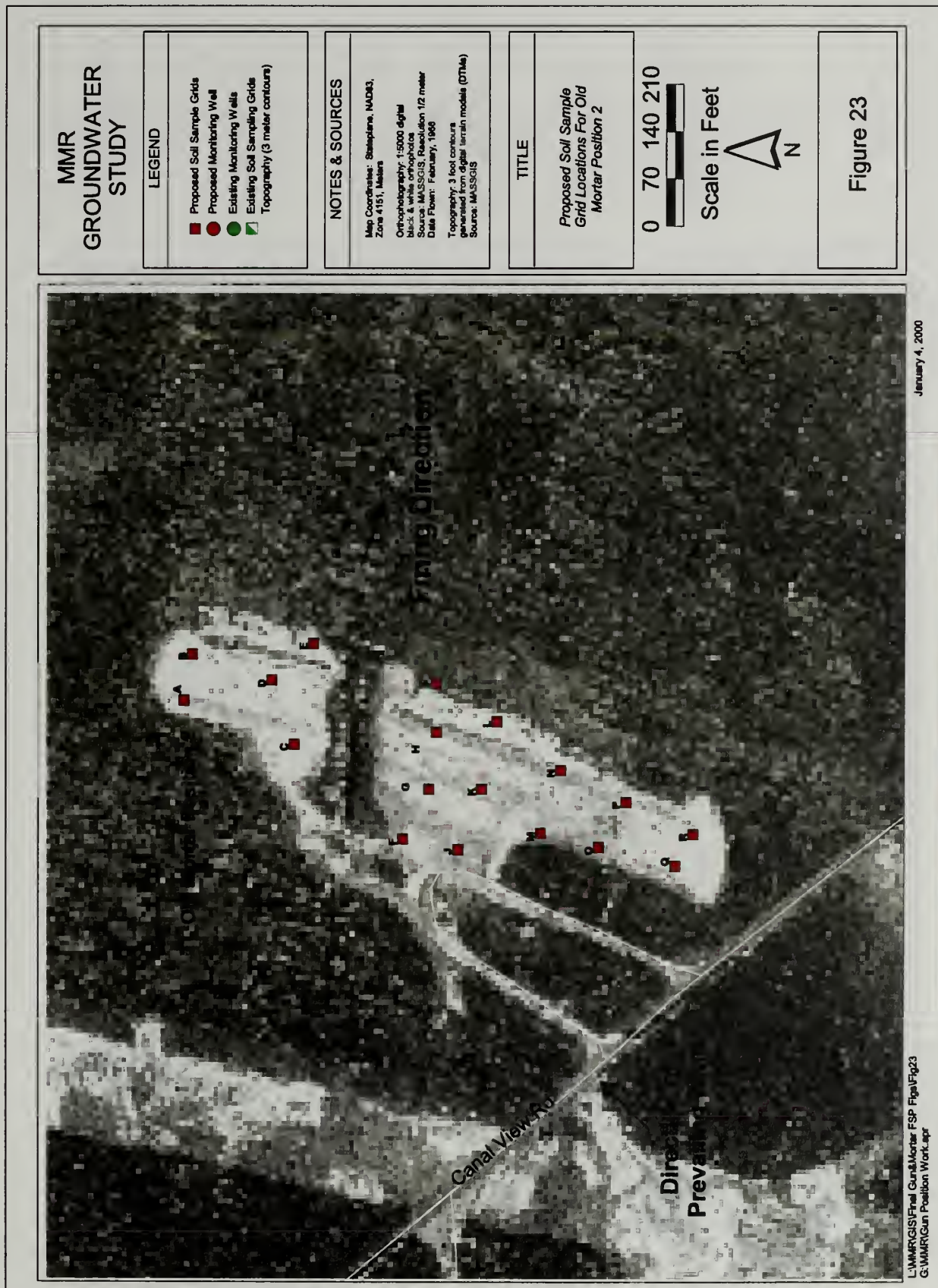






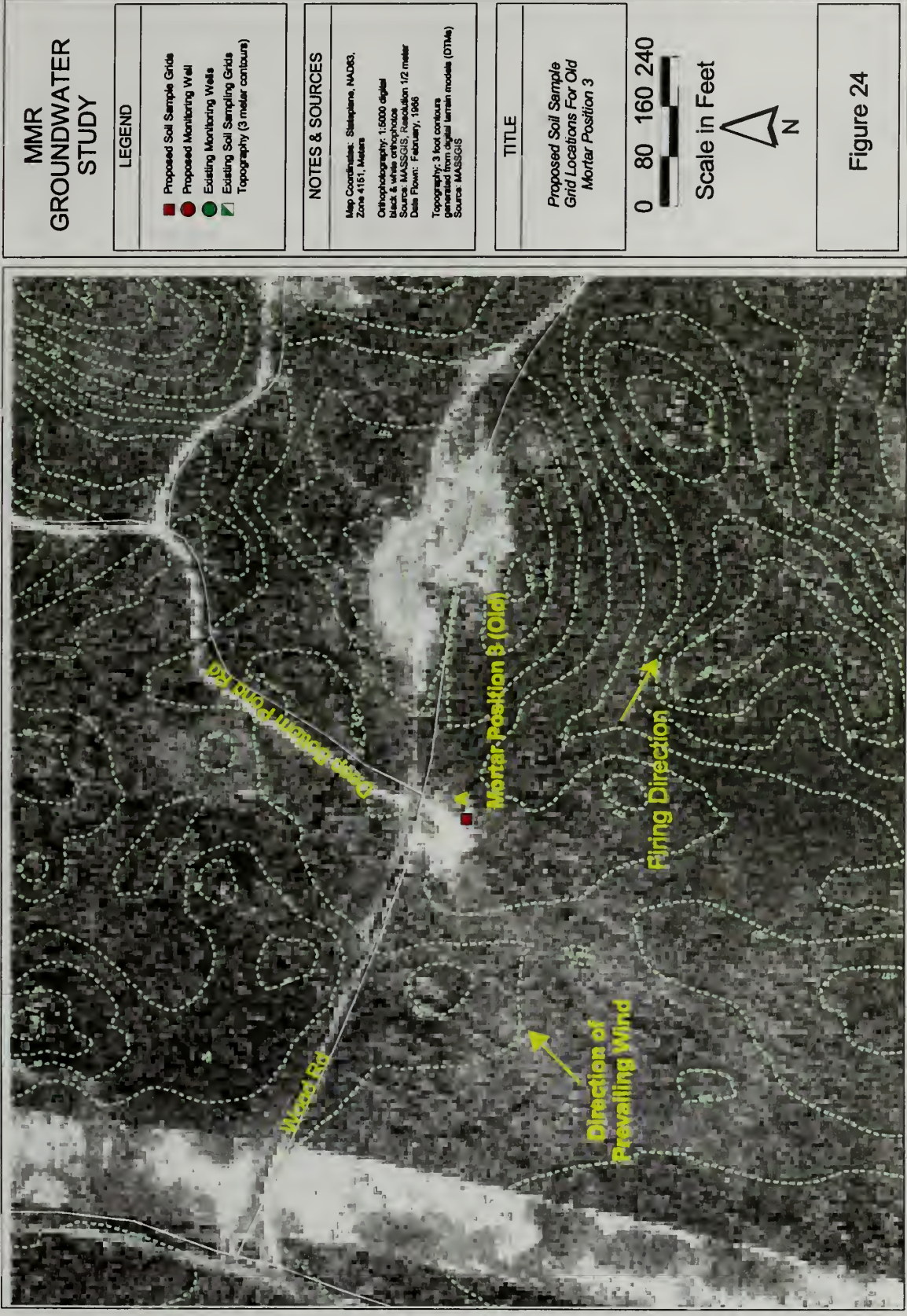


# Final Phase II (a) Gun/Mortar FSP













# Final Phase II (a) Gun/Mortar FSP







MMR  
GROUNDWATER  
STUDY

LEGEND

■

Proposed Soil Sample Grids

●

Proposed Monitoring Well

●

Existing Monitoring Wells

■

Existing Soil Sampling Grids

Topography (3 meter contours)

NOTES & SOURCES

Map Coordinates: Stateplane, NAD83,  
Zone 4151, Meters

Orthophotography: 1:5000 digital  
black & white orthophotos

Source: MASSGIS; Resolution 1/2 meter

Data Date: April, 1994

Topography: 3 foot contours  
derived from digital terrain models (DTMs)

Source: MASSGIS

TITLE

Proposed Soil Sample  
Grid Locations For  
Mortar Position 7

0 100 200 300

Scale in Feet

N

Figure 26



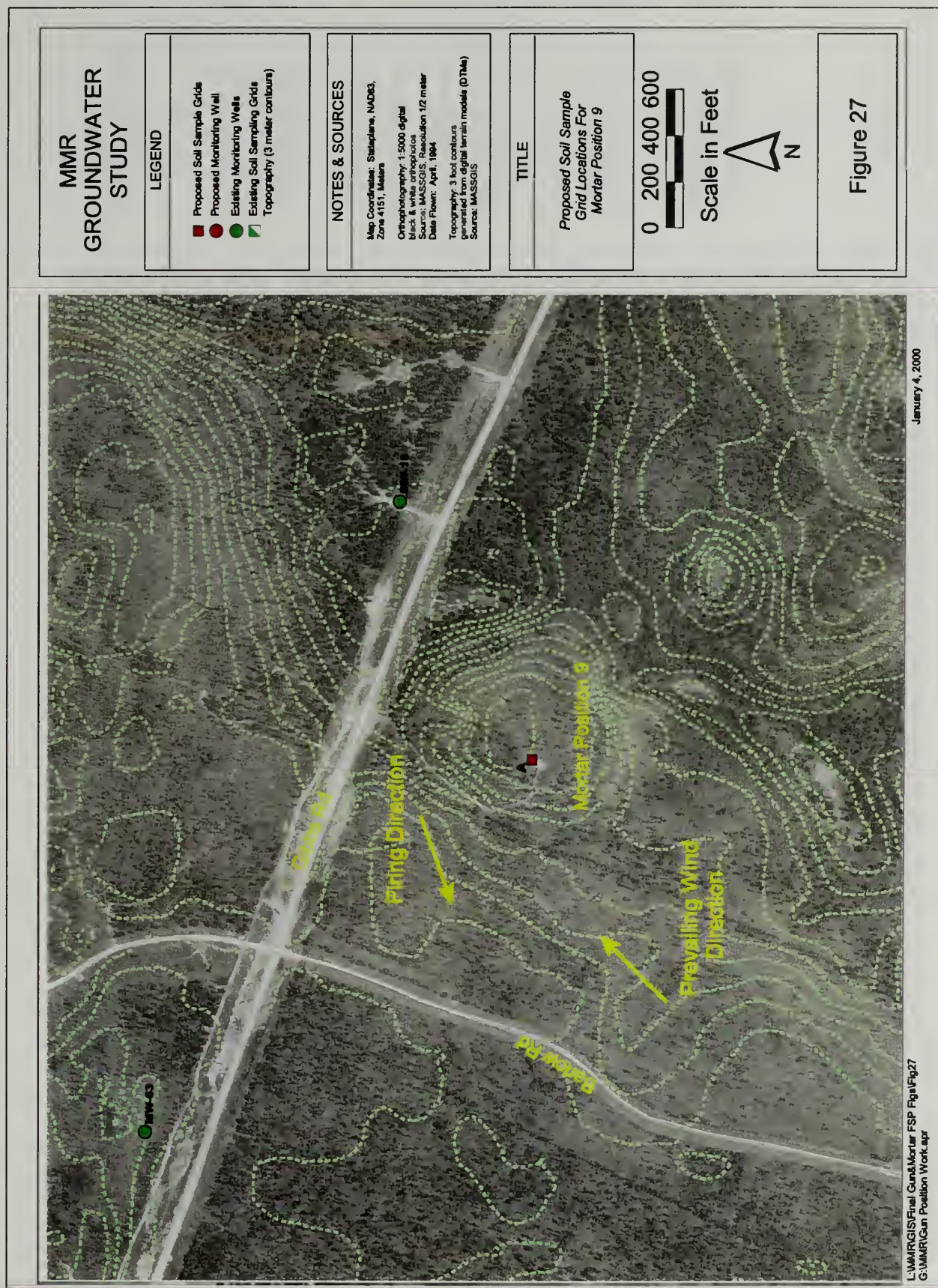
January 4, 2000

L:\MMRGIS\Final Gun&Mortar FSP Figs\Fig26  
G:\MMRGIS\Gun Position Work.apr





# Final Phase II (a) Gun/Mortar FSP



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G:\MMR\Gun Position Work.apr

January 4, 2000





# Final Phase II (a) Gun/Mortar FSP

## MMR GROUNDWATER STUDY

### LEGEND

- Proposed Soil Sample Grids
- Proposed Monitoring Well
- Existing Monitoring Wells
- Existing Soil Sampling Grids
- Topography (3 meter contours)

### NOTES & SOURCES

Map Coordinates: Stateplane, NAD83,  
Zone 41S, Meters  
Orthophotography: 1:5000 digital  
black & white orthophoto  
Source: MASSGIS, Resolution 1/2 meter  
Date Flown: April, 1943  
Topography: 3 foot contours  
generated from digital terrain model (DTM)  
Source: MASSGIS

### TITLE

Proposed Soil Sample  
Grid Locations For  
Old H Range Mortar Positions

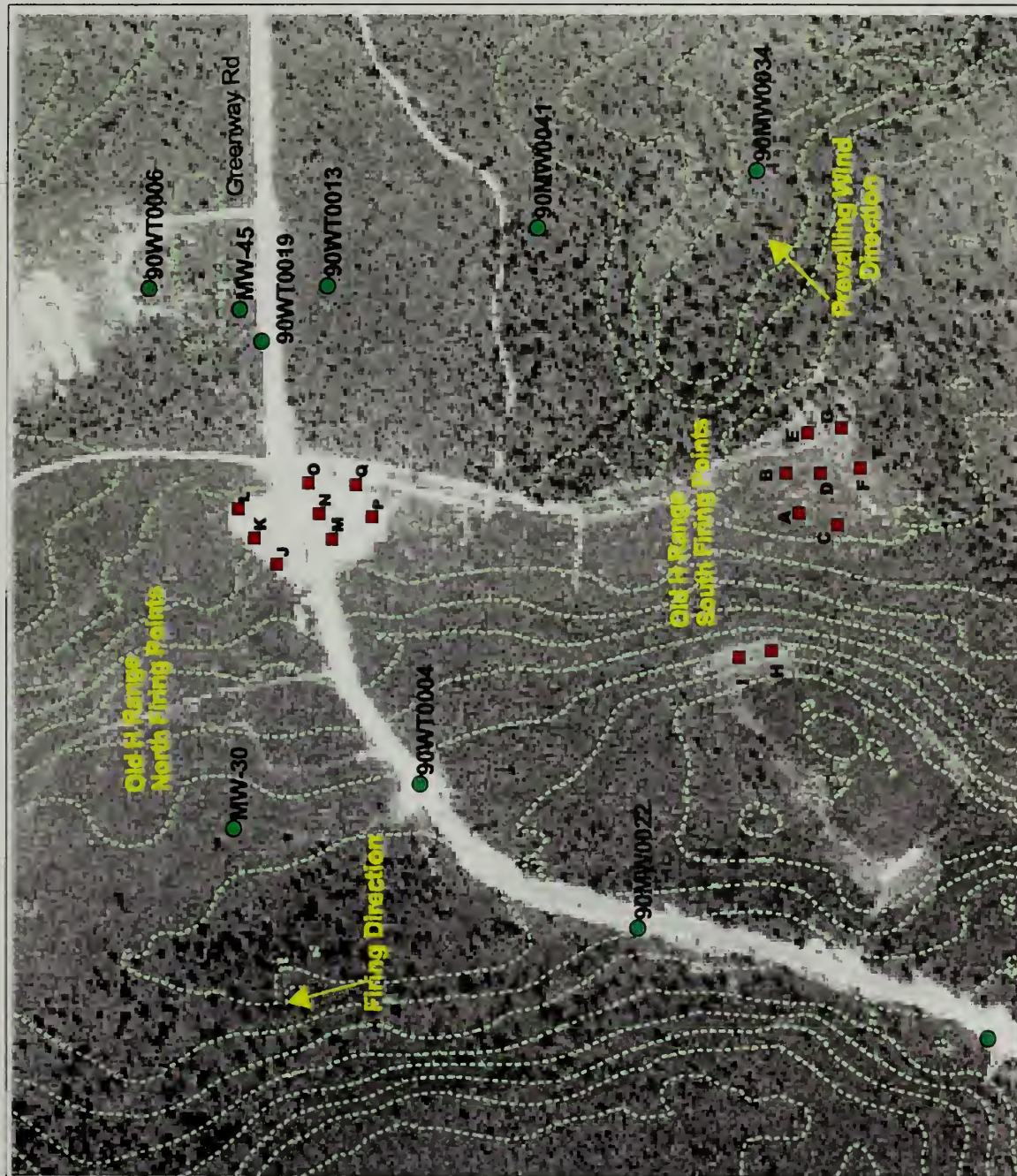
0 100 200 300



Scale in Feet



Figure 28



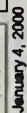
L:\MMRGIS\Final Gun&Mortar FSP Figs\Fig28  
Gun&Mortar Position Work.apr

January 4, 2000



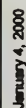


● ● ● ● ●









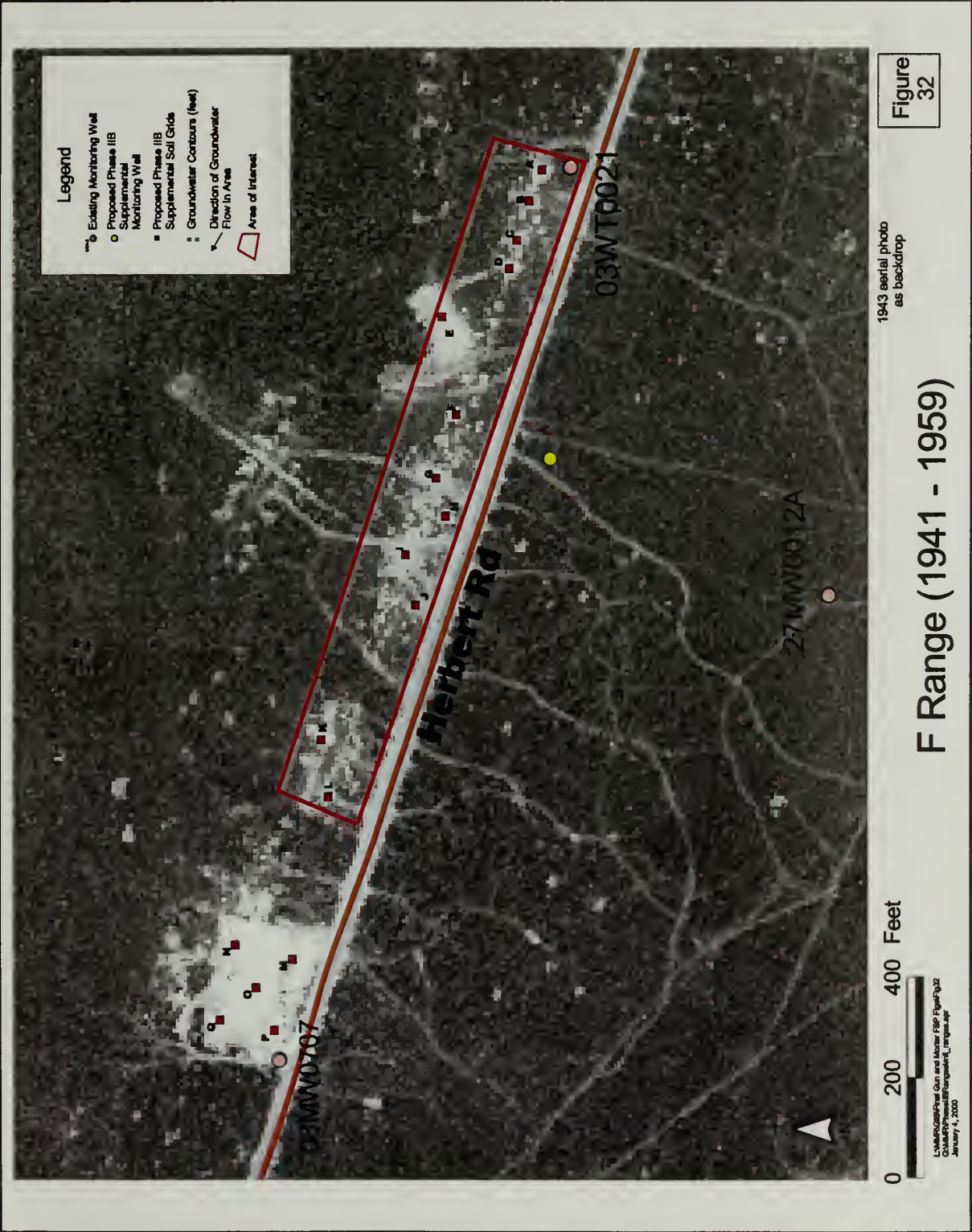






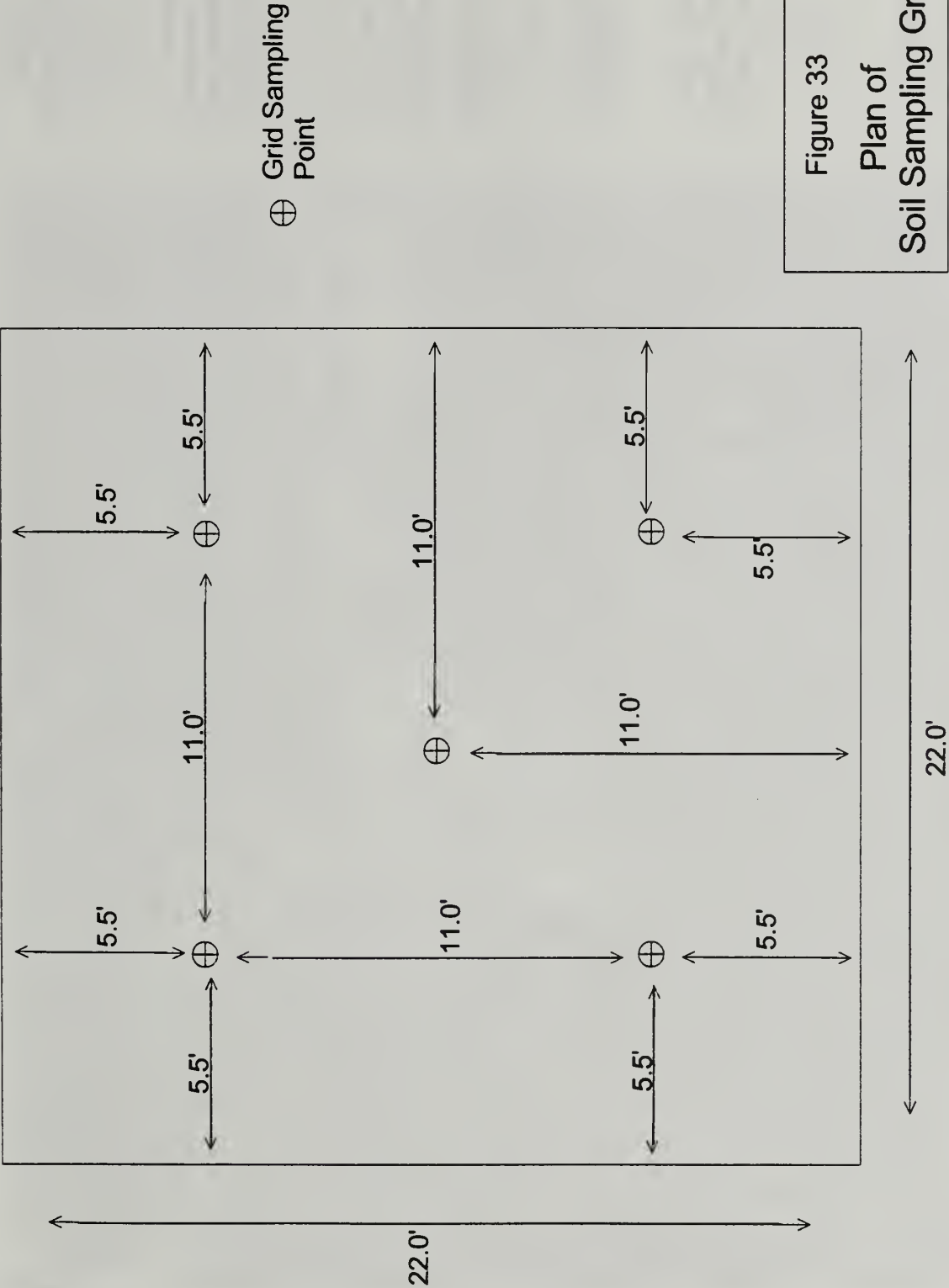




















# Final Phase II (a) Gun/Mortar FSP

## Attachment A. Regulatory Agency Comments and Responses on Draft FSP

### General Comments:

1. (9/8/99) As mentioned below in Specific Comment No. 3, it appears that numerous training exercises have occurred in areas previously shown to contain low level soil contamination. Please provide to EPA a list of all positions currently utilized for training. This list should specifically include areas utilized for mechanized artillery training exercises, in addition to all other relevant training.

*Provided by email 10/6/99 (see attached table).*

2. (9/8/99) The Phase II(a) work plan said that NGB would consider additional information from the archive search report before finalizing sites to investigate. It is not clear how this information was integrated into the work plan. NGB should indicate how the information was used in this plan. In the cover letter NGB indicates that additional information will be followed up in Phase II(b). If so, that statement should become part of this FSP.

*The ASR did not contain additional information regarding firing or bag burning at these positions, as indicated at the top of page 2 of the workplan. A statement regarding overlap with Phase 2b has been added to the Introduction.*

3. (9/8/99) As requested by NGB, an attachment at the end of this document lists all 34 Gun and Mortar positions to be sampled, with a priority ranking for each. This list may change as results are obtained during the course of the investigation of the Gun and Mortar positions.

*The priorities have been added to Table 1 of the FSP. Table 1 also shows the positions that have been sampled during Phase I.*

### Specific Comments:

1. (9/8/99) Page 1, Paragraph 1 - The following change should be made: change "the Phase I results indicate that there is no evidence of munitions related contaminants at mortar positions" to "The limited Phase I investigation did not find evidence of munitions related contaminants at mortar positions."



## Final Phase II (a) Gun/Mortar FSP



*The referenced text is a quote from an approved workplan and as such cannot be changed. If EPA feels that additional information suggests the quote is no longer accurate, this can be indicated.*

(9/20/99) As proposed by NGB, include a sentence stating that EPA has requested additional sampling in light of the limited number of positions sampled in Phase I.

*A sentence has been added as requested.*

2. (9/8/99) Page 1, Paragraph 1 – NGB should strike the reference to a finding of no imminent threat to human health. A risk assessment has not yet been conducted under this study.

*It is not clear what EPA means by “risk assessment has not yet been conducted”. Risk assessment is continually being performed under the IAGS, by virtue of comparing measured concentrations of contaminants to risk-based benchmarks and drinking water criteria. EPA has not approved plans for a quantitative risk assessment, although a workplan for this was submitted over two years ago. In any event, the referenced text is a quote from an approved workplan and should not be changed.*

(9/20/99) EPA's comment stands as originally proposed. The statement utilized in the report is misleading, and that EPA missed this statement in the workplan is not relevant.

*The referenced text has been deleted. A paragraph that better explains the CS-18 study has been added to the Introduction.*

3. (9/8/99) Page 1, Paragraph 3 - Soil sampling has previously shown that GP-9 (Installation Restoration Program site CS-18) contained shallow soil contamination. This position has since been used numerous times for non-firing training exercises. These exercises have served to mix the shallow surface soils throughout the entire area extensively. Have similar activities occurred at GP-16 or other gun and mortar positions (see General Comment No. 1)? Please comment on the effect these training exercises would have on the contaminants previously detected at these sites, and what effect these activities will have on our ability to evaluate the previous soil composite sampling scheme at GP-16.

## Final Phase II (a) Gun/Mortar FSP

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*See General Comment No.1. Regarding the impact of shallow mixing on the soil sampling, it depends on the depth of mixing. As indicated in the Phase I Gun/Mortar FSP, the areas were periodically graded to smooth out ruts. It seems likely that the depth of grading would extend from 1-2 feet. Considering this information, it may be appropriate to modify the proposed sample depths.*

(9/20/99) EPA concurs with modifying the proposed sample depths, and requests the following changes. Soil samples should be collected from 0-6 inches and 18-24 inches, and not 0-3, 0-6, and 6-12 inches as originally proposed. No changes are to be made to the size of the grids, and the proposed depth changes apply to the Draft Phase II(a) Sampling Plan for Gun and Mortar Positions only. This change will significantly decrease the number of soil samples to be collected as part of this effort.

*The change on depth intervals has been made to the FSP. Regarding the effect of mixing on the ability to evaluate the previous soil composite sampling scheme, the Guard has agreed to sample the indicated grid at GP-16 using both the old and the new grid arrangements. This will allow the results from the two grids to be directly compared in an area where propellant-related compounds are known to be present. The sampling plan has been changed accordingly.*

4. (9/8/99) Pages 2 and 3, Table 1 - Table 1 does not contain the former F Range, which was a gun position utilized throughout the 1940's. This position was located along Herbert Road in the current BA-1 Training Area, as noted in the U.S. Army Corps of Engineers (ACOE) Archive Search Report (ASR). In addition, the ASR states that the former R Range, which was located on the west side of the current IBC Range until approximately 1990, was used as a tactical firing position for the 81mm and 4.2 inch mortar HE rounds (ASR, p. 31). The ASR should be reviewed before finalizing this report, and should be listed in the References section.

*Considering the other activities which have occurred in Training Area BA-1, we propose to include the F Range in the Supplement to the Phase IIb Workplan. Similarly, the R Range is mentioned as part of the IBC Range in the Phase IIb Workplan. It may be more appropriate to design investigations of these areas considering all of the potential releases, rather than just the potential releases due to artillery or mortar fire.*

(9/20/99) Regarding the former F Range, EPA's original comment still stands, and the F Range is requested to be addressed as part of this Phase II(a) Sampling Plan for Gun and Mortar Positions. Regarding the former R Range, EPA concurs with the NGB's

## Final Phase II (a) Gun/Mortar FSP

request to address this range as part of the multi-use IBC Range complex in the Phase II(b) Work Plan.

*The Former F Range has been added to Table 1, and a figure depicting proposed sampling locations has been added as Figure 32. The sampling grids in Figure 32 are concentrated in clearings visible in the 1943 aerial photo that were somewhat revegetated by 1955, and largely revegetated by 1966. These clearings are consistent with the reported use period for the Former F Range. The large clearing on the west side of these apparent firing points, around where 03MW0707 is located, has survived through the years based on a review of the IRP aerial photos for 1943, 55, 66, 77, 86, and 91. However, currently it appears that the clearing is larger and slightly west of the 1943 clearing. The historical use of this clearing will be discussed with persons knowledgeable of the site history, to determine an appropriate sampling program. Sampling of this area will be covered as a change to the Phase II (b) Workplans or the Gun/Mortar FSP.*

5. Page 3, 2<sup>nd</sup> Paragraph - Please explain the rationale behind choosing a “sampling density of approximately three grids per acre”. Section 4.3 of the Final Action Plan states that each focal area for soil sampling (e.g., each gun and mortar position) will be marked with one or more 30-foot square grids (subsequently replaced with two 22-foot square grids for Phase II(a) sampling). A minimum of 5 grids will be used to sample each acre of a given focal area. For the gun and mortar positions, the one-acre focal area would encompass both the firing area and the bag burning area at that particular position.

*The sampling grid density was chosen so that the sampling grids would cover all of the apparent cleared areas, and the proposed number of samples would equal the number that was discussed with EPA at our meeting of January 12, 1999 to discuss the Phase IIa soil sampling approach. The meeting minutes are documented in a fax dated January 20, 1999. The fax indicates an estimated number of 226 sampling grids, while the workplan shows 228 sampling grids.*

6. Figures - Please number the pages which contain the figures, as is represented in the Table of Contents.

*The figure pages have been numbered.*

7. (9/8/99) Figures - Both Gun Position-18 (GP-18) and Mortar Position-3 (MP-3),



## Final Phase II (a) Gun/Mortar FSP

although listed in Table 1, are not located in any of the Figures in the report. Please provide similar figures and proposed grid locations for these positions to the regulatory agencies for review.

*The gun and mortar positions that were sampled in Phase I have not been identified for further sampling. These include GP-7, -16, and -18; and MP-3, -5, -6, and -8.*

(9/20/99) Response accepted.

8. (9/8/99) Figure 1 – In the 7/2/99 NGB response to EPA's 5/13/99 comments on the Preliminary Phase II (a) FSP for Gun and Mortar Positions, NGB states that "The Old H Range has been added to Figure 1 in accordance with the Draft Phase II (a) Workplan which identified this mortar range on the southeast side of MMR." This has not occurred. Please revise the figure accordingly. In addition, please add the former F Range located in the southern portion of the BA-1 Training Area. This range was also identified as an artillery firing range in the 1999 ACOE ASR.

*The Old H Range has been added to Figure 1. See Specific Comment No.4 regarding the F Range.*

(9/20/99) See EPA's additional comments on Specific Comment No. 4 above, and add the Former F Range to the Figures section as appropriate.

*The figure for Former F Range (Figure 32) has been referenced in the text and in the Figures section.*

9. (9/20/99) Page 5, Section 3.0 – Dioxins/furans analysis is to be conducted on discrete samples for the 0-6 inch and 18-24 inch layers in each of the two grids which are to be overlain at former Grid GHM at GP-16. A potential data gap exists without these analyses, and the already scheduled resampling of the grid at GP-16 which is known to formerly contain detectable levels of contaminants indicative of powder-bag burning provides the best opportunity to assess this.

*This issue requires further discussion and coordination between the Guard and EPA. A letter from the Guard to EPA was provided on October 21, 1999 requesting additional information. In the meantime, the Guard is proceeding with the comparative grid evaluation for GP-16, and will adjust the sampling program as needed when this issue has been resolved.*

# Final Phase II (a) Gun/Mortar FSP



Gun and Mortar Position Use  
Oct 1998 to Sept 1999

Dates	GP-2	GP-5	GP-6	GP-7	GP-8	GP-9	GP-10	GP-11	GP-12	GP-14	GP-16	GP-20	GP-24	MP-1	MP-2	MP-3	MP-4	MP-9
1998																		
2 Oct - 15 Nov	DIV					FA	FA	FA			FA	FA						
1999																		
9 Jan - 3 Mar	DIV			FA	FA		FA	FA	FA				FA			IN		
4 Apr - 16 May		FA	FA	FA	FA	FA	FA	FA	FA	FA	DIV	FA	FA	IN	IN	IN	IN	
20 May - 14 Jun	EN BN								FA	FA			EN BN					IN
15 Jun - 30 Jun	EN BN								IN	IN								
1 Jul - 8 Aug		QM				REGT												
9 Aug - 29 Aug						REGT	REGT											
9 Sept - 26 Sept	TC		FA	FA	FA	FA	FA	FA	FA	FA	FA	FA						

Acronyms...

FA = Field Artillery

IN = Infantry

EN BN = Engineer Battalion

DIV = Divarty Artillery Command

QM = Quartermaster Battalion

REGT = Regimental Training Technical Institute

TC = Transportation Company

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Bourne, MA 02532



